THE

FOUNDRY TRADE JOURNAL

WITH WHICH IS INCORPORATED

THE IRON AND STEEL TRADES JOURNAL

VOL. 50 Thursday, February 22, 1934 No. 914

PUBLISHED WEEKLY

Subscription Terms: 15s. per annum.
Foreign and Colonial: 17s. 6d. per annum.
All Subscriptions are payable in advance.

All Communications to be addressed to the Editor, the Advertisement Manager, or the Publisher of

THE FOUNDRY TRADE JOURNAL,
49, WELLINGTON STREET, LONDON, W.C.2

Telegraphic Address: "Zacatecas, Rand, London."
Telephone: Temple Bar 3951 (5 lines).

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THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTE OF BRITISH FOUNDRYMEN, THE NATIONAL IRONFOUNDING EMPLOYERS' FEDERATION, THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION, AND THE FOUNDRY TRADES' EQUIPMENT AND SUPPLIES ASSOCIATION

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Forthcoming Events

MARCH 7-8

Institute of Metals:—Annual general meeting, 10 a.m., in the Hall of the Institution of Mechanical Engineers, Storey's Gate, London. Annual dinner and dance, 7 p.m., at the Trocadero Restaurant, Piccadilly Circus, London.

MARCH 9

Institute of Metals (Sheffield Local Section):—Meeting at the University at 7.30 p.m. "Nickel-Chrome Plating," Paper by Frank Mason.

Institute of British Foundrymen

MARCH 1

Scottish Branch:—Meeting in the Royal Technical College, Glasgow, at 7.30 p.m. Discussion on Report of Steel Castings Research Committee (Joint Meeting with the Institution of Mechanical Engineers and the West of Scotland Iron and Steel Institute).

MARCH 2

Birmingham, Coventry and West Midlands Branch:—Meeting at the James Watt Memorial Institute, Birmingham, at 7.30 p.m. "The Machining of Cast Iron," Paper by H. Beeny.

MARCH 3

Lancashire Branch:—Meeting at the Engineers' Club, Manchester, at 4 p.m. "Some Aspects of Non-Ferrous Founding," Paper by A. Logan.
Scottish Branch (Falkirk Section):—Meeting at Falkirk Technical School at 6 p.m. "Problems I Have Met," Paper by W. McArthur.

MARCH 6

Lancashire Branch (Burnley Section):—Annual general meeting at the Municipal College, Burnley, at 7.15 p.m. "The Annealing of Castings," Paper by J. Jackson.

MARCH 7

Lancashire Branch (Preston Section): Meeting at Technical College, Preston, at 7.30 p.m. "Metal-Treatment by the Oxy-Acetylene Process." Paper by H. P. Smith. (Illustrated by cinematograph film.)
London Branch: Meeting at Charing Cross Hotel, W.C.2, at 8 p.m. "Potentialities of Cast Iron," Paper by A. B. Everest.

MARCH 9

Middlesbrough Branch:—Meeting at the Cleveland Scientific and Technical Institute at 7.45 p.m. "Steel Castings, with Special Reference to the Trepenas Process," Paper by John E. Mercer and D. K. Barclay.

MARCH 10

Scottish Branch:—Annual general meeting at the Royal Technical College, Glasgow, at 4 p.m. "Coke Research," Paper by Wm. Davidson.
West Riding of Yorkshire Branch:—Meeting at the Technical College, Bradford, at 6.30 p.m. "Porosity," Paper by E. Longden.
East Midlands Branches:—Annual dinner at Loughborough.

To-day's Decision

To-day the National Federation of Iron and Steel Manufacturers will make its decision with respect to the scheme of reorganisation for the iron and steel industry. There has been a good deal of speculation as to the outcome and, as usual, the daily Press has known a great deal more about what is going on than those immediately concerned, for almost every conceivable variation of the possibilities has been as confidently maintained by one section of the Press as likely to be accepted as it has been stated as equally confidently likely to be rejected by the other. Every concern in or related to the industry will feel the effects of the change. In January, 1932, the National Federation drew attention to the need for a tariff, and at the end of April a duty of 33⅓ per cent. was imposed for three months by the Import Duties Advisory Committee. In June a committee of the Federation was appointed to draw up a scheme of reorganisation. The duties, which would have expired in July, were prolonged for ten years, subject to reorganisation being carried out if continuation was hoped for. The first report of the National Committee was published, but was regarded as the framework of a scheme rather than the scheme itself. The Import Duties Advisory Committee gave indications at intervals that it was not satisfied with the progress being made, and indeed the chairman, Sir George May, hinted that the Government would do it if the industry did not. In February, 1933, a year ago, a draft scheme was prepared, and sent in March to the Import Duties Advisory Committee. It was made public in April and was supported by 28 out of 34 members of the National Committee originating it. This was the scheme foreshadowing an Iron and Steel Corporation of Great Britain to co-ordinate about a dozen trade associations. This scheme proved unacceptable to the industry and two sub-committees, the A and B sub-committees, were asked by the Federation to go into the matter further.

Speaking broadly, the schemes they have produced are such that A is the less drastic and more likely to be supported by a majority in the Federation, while B is the more comprehensive and less acceptable to the keen individualism on which the industry has in the past been built. However, voluntary acceptance of a scheme is worth a great deal. The last move, following Sir John Beale's complaint that uncertainty about continuance of duties was holding up capital expenditure in South Wales, was a letter from the Import Duties Advisory Committee to each member of the National Federation, made public a few days ago, reviewing the situation and calling for a definite decision. The difficulties and delays are understandable. An industry does not pass readily from a free trade to a protection basis without growing pains. That a decision will be reached and that, when reached, it will be loyally accepted by those who are opposed to it, will be the devout hope of all those who have the welfare of the industry at heart.

From the foundry point of view, this meeting is most important from several angles. Primarily, as we have pointed out in this column on previous occasions, the prosperity or depression of the iron and steel trades is most profound in its influence on the foundry industry. Next it will be possible to ascertain, by analogy, what is likely to happen to the foundry industry. Will it be excluded or embraced? Or again, as is more likely, will the position be left open for further discussions to align with the final scheme evolved? The lack of limelight accorded to the reorganisation of the iron and steel industry does not make it any less important than the German Nazi revolution, the Italian Fascist administration, the Austrian Heimwehr activities, the American N.I.R.A. schemes or the Paris street fighting, as nation-wide co-operation in basic industries is revolutionary from the British point of view. It is not easy for a nation of individualists suddenly to adapt itself to strange conditions. Such schemes are quite useless during boom conditions, when there is work for

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everybody and demand places prices on a profit-paying basis, but contracting markets and cut-throat competition which were so much in evidence in 1931 command the attention of those who have the future well in mind. The reorganisation schemes then are a concrete attempt to minimise or even eliminate the evils attendant upon contracting markets. The foundry industry will indeed read to-morrow's serious Press with profound interest as giving an indication of the industrial future of Great Britain.

British Industries Fair

The foundry industry now utilises this great annual fair as its shop window. All the great foundries catering for the lighter industries, such as Allied Ironfounders, Harper's, Qualcast, Leys, and Radiation, have magnificent displays. At Castle Bromwich the exhibits are mainly of castings and sheet metal worked up into articles of commerce, supported by concerns which supply the raw materials and machinery, the latter mainly for the sheet-metal work, probably due to the fact that the foundry-equipment industry organises its own triennial exhibitions. For raw materials, Stanton, Staveley, Stewarts and Lloyds, and the United Steels, represent the large pig-iron-producing firms. It should be realised that the Castle Bromwich show is enormous, and with the object of saving the time of our readers who visit the Fair and putting on record some of the outstanding features, we have included in this issue a general description of the more interesting exhibits.

Notes from I.B.F. Branches

The February meeting of the Burnley Section of the Institute of British Foundrymen was held on February 13 at the Municipal College, Burnley. The President, Mr. J. Taylor, opened the meeting, which was well attended. He introduced the lecturer, MR. R. H. C. WEEKS, of Blackburn, who read a Paper on "Ironfoundry Practice Modernised." Mr. Weeks' lecture was illustrated by lantern slides. After the lecture MR. F. HARRIS proposed and MR. L. WHARTON seconded a vote of thanks to Mr. Weeks, to which he replied. After a hearty discussion the meeting was closed by the President.

British Commercial Policy

The Grand Council of the Federation of British Industries recently adopted a report on British commercial policy for submission to the Government. The Council comments on the growing competition of countries with standards of living far out of relation to those existing in Great Britain, and recommends that the Government should arm itself with (*a*) power to impose a quota upon the import of any article from any or all foreign countries. This power should include that of imposing a general quota applicable to all countries, based upon the volume of imports during a given year; a quota applied to one or more countries only based upon a given year; or a quota imposed upon all or any country upon a basis to be decided by the Government; (*b*) power to regulate foreign exchange, should such a course be necessary to protect British interests; (*c*) powers to impose "special duties" against the imports of countries which (i) sell their products in this market at a price less than that in the country of origin; (ii) enjoy a bounty on their exports as the result of the depreciation of their exchange; (iii) grant export subsidies, either direct or indirect.

THE STANTON IRONWORKS COMPANY, LIMITED, have secured a substantial order for cast-iron pipes from the Copenhagen municipal gas undertaking.

Book Reviews

Industrial Accountancy, by H. A. SIMPSON, F.C.W.A. Published by Longmans, Green & Company, Limited, 39, Paternoster Row, London, E.C.4. 270 pp.; 8½ × 5½ in.; 101 charts and tables. Cloth cover, 10s. 6d. net.

There are many books on the market dealing in general with the subjects of accounting and costing, but there are very few that describe in detail the methods and operations as applied to particular industries. This work fills a gap as regards the manufacture of steel, and it can be read with profit by those who are responsible for the management of the larger type of foundry, provided that they adapt to their own case the principles set out by the author.

At a time when the foundry industry is seriously directing its attention to this important question of costing, it is of interest to note that the iron and steel industry is endeavouring to set up a uniform cost system, and that in due course a report will be issued. Therefore, to all those who are interested in the question, a study of this book will be of assistance, as it explains in detail the system in use in one of the largest organisations in the heavy industries of this country.

In this work, the author does not limit himself to a general description of costing methods as applied to the steel industry. The subject being closely linked with work planning, programming and progress, many principles relating to these problems are explained, and they apply also to the larger undertakings, whether they be concerned with the manufacture of billets or of engineering castings.

In a steelworks there are many processes and auxiliary services that are interlocked, and, therefore, the costing system is bound to be complex. The main object of the system described is to save time and labour, with a resulting saving in expense. A means of obtaining rapidly complete statements, relative to costs, wages, output, stocks, either for one department or for the whole undertaking, is also aimed at.

In the system described, these aims are achieved by a complete centralisation of all clerical work in the general offices, and by placing the control of all recording operations throughout the works in the hands of the office administrator. In this respect, a high degree of office mechanisation is necessary, and a precise time schedule is worked out for the reception of mails, order forms, invoices, wage sheets, etc. Among other illustrations of the results obtainable by such a system, the author shows that wages clock cards can be calculated at a rate of 2,400 per hour; repair job cards can be added at a rate of 90,000 per hour; a pay roll of 5,000 men can be completed in three hours; and a monthly profit-and-loss account for each product in each department can be completed on the first day after the end of the month.

Other important features of the system are: The establishment of standard costs, based on conditions of economic production, for comparison with conditions as they exist; the application of standard costs at every stage of manufacture; the liaison between the various departments and the central office; the method of controlling deliveries of raw materials and fuel; and the method of interlocking cost accounts with financial accounts.

The first nine chapters of the book describe the operations of recording and accounting; following an introductory chapter, Chapter II sets out the classification of the undertaking in its various departments from the standpoint of accounting and costing; Chapter III explains the scientific use of numbers and codes as applied to the system; Chapter IV describes the manner in which the system is centralised. The following chapters, including Chapters X to XV, that deal more particularly with costs, follow step by step the operations performed in the various departments and the manner in which they are connected. The reader is methodically conducted throughout the whole process, as in a works visit. The numerous standardised forms and cards used in the system are printed with figures serving as examples. There is an appendix at the end of the book, giving definitions of certain terms, and a two-page index.

The system described in this book is that used by the United Steel Companies, Limited, and full acknowledgment is due to this firm for allowing the details of their office organisation to be disclosed for the benefit of others.

V. D.

Marken bezuchnungen un Feuerfest-Fach und im Ofenbau. (Trade Marks in the Refractory and Furnace Industries.) Collected by L. LITINSKY. Published by Verlag L. Litinsky, Leipzig, O.27. Price 6 renten marks.

When we first examined this list of 1,500 trade marks, we were not too impressed, as Silacene was missing and Cupoline was attributed to John "Charles" Smeeton, of 15, Victoria Street, S.W.1, but a more profound study shows it to be not too bad. The Scottish brands of firebricks and all General Refractories productions seem to be reasonably complete. Moreover, in addition to German, it includes British, American and French brands. It should be of use to manufacturers of refractories in ascertaining where materials come from and what trade marks have been already registered.

Publications Received

Mitteilungen aus dem Giesserei-Institut der Technischen Hochschule Aachen. (Collected Works from the Foundry Institute of the Technical High School of Aix-la-Chapelle). Edited by PROFESSOR DR. ING. E. PIWOWARSKY. Vol. III.

This is a collection of research Papers recently published by members of the staff of this well-known centre of foundry research. Actually, they are assembled reprints from various sources, and one of them, "The Resistance of Iron to Corrosion," is in English, as it was a contribution by Dr. Nipper and Prof. Piwowarsky to the American Press. A second, on "Heat-Resisting Alloys," is in French. Altogether there are 29 Papers, ranging from oil-sand cores to the gas content of aluminium alloys; from the influence of aluminium on cast iron to problems relating to chaplets. It is a pity that the book is not for sale, as it contains some excellent Papers.

Armstrong-Whitworth Record. Vol. 2, No. 4.

The cleverness of this book is that the Editor by some uncanny process converts his firm's catalogues into an extremely handsome quarterly magazine. Never does one receive the impression that the main object of the book is to make propaganda for Armstrong-Whitworth specialities. This particular issue contains a splendid article by Mr. S. E. Dawson on special cast irons, which crystallises most of the research work he has previously published about non-magnetic cast iron. We counsel our readers to be placed on the mailing list for this very interesting quarterly publication.

Catalogue Received

Piston Rings. The British Piston Ring Company, of Coventry, has sent us an advance copy of the Brico Catalogue and Directory for 1934. It carries a particularly striking cover—a symmetrical female form. The catalogue is well indexed and full of essential business information. No doubt it will be familiar to many of our readers, as 9 tons, or 35,000 copies, have been distributed.

Patternmaking*

By F. J. Edwards

In discussing the subject of patternmaking, two postulates should be kept constantly in mind, the first being that a pattern (unlike, say, a piece of furniture) is not an end in itself, but an intermediary between design and casting: a mould-forming agent. The second postulate is that the degree of refinement economically justifiable in any specified pattern will vary with the accuracy or quantity of the castings required. An early recognition of these postulates and their co-relationship should go far to explain many of the apparent contradictions met with in the art and craft of patternmaking, and, as a corollary, help one more justly to estimate the merits and demerits of any particular pattern.

It should be understood, for example, that the pattern for a "one-off" job—say, a tool-jig or fixture, which may never be required again—will generally lack those aids to quick and accurate casting production demanded in repetition work. This does not mean, of course, that the making of a "lack-lustre" pattern is as simple as its unfinished appearance may suggest; on the contrary, since one is expected to produce a pattern of this kind in, perhaps, one-half or one-third of the time spent on a similar pattern for production work, constructive thought must travel at double or treble its normal speed. The elimination of non-essentials, and the adoption of short cuts, becomes a necessity. Here, as elsewhere, successful short cuts imply a clear view of the objective along with the discriminative ability to select the one best path to its attainment.

The Rule of the Craft

With these "one-off" jobs, again, the patternmaker (quite properly) enjoys greater latitude of action. He is licensed to inflict on the foundry "exhibition" work which would never be tolerated with ordinary "production" patterns. This licence, however, is limited to *possible* moulding methods, and does not cover the *impossible* contraption, which occasionally finds its way into the foundry to embarrass the moulder and humiliate its creator. That is to say, although the most unorthodox expedients may be employed in this class of work, the faculty of inventiveness cannot be allowed to run riot. Imagination must be subservient to practical politics. For the moulder of the job may not happen to possess that flair for executing the "impossible" in which the "invincibles of the old school" pardonably gloried. Then the patternmaker is called upon to explain the way out! If his methods are based on logical reasoning from experience, all is well—since the moulder, given the cue, invariably proves equal to the occasion: his reach exceeds the patternmaker's grasp. If, on the other hand, speed has obscured the lessons of experience, or dethroned logic, the patternmaker is found guilty of breaking the first rule of his craft: "A pattern must be made to mould!"

This leads to a recognition of the tuitionary value of the "rush, one-off" jobs. By speeding up thought action, and allowing insufficient time for the balancing of pros and cons, "rush" jobs inevitably engender questionable practices—in the concrete. These form valuable object lessons to the young patternmaker on "what *not* to do"! With the actual pattern before him, the moulder is in a better position to express his likes and dislikes than he could be expected to do from a hypothetical case based upon a blue-print.

Yet more fortunate is the novitiate patternmaker—from an educational point of view—when his mistakes remain undetected until they are buried. For just as the actual, wooden mistake, if observed, converts the taciturn moulder into a voluble (and valuable) critic, so it enables the still less articulate mould to preach an excellent sermon. And the mould never misses a mistake! These "sermons in sand," moreover, are not only very lively, but (as the author can vouch from personal experience) they live in the mind as permanent pictures—ineffaceable, unforgettable! A pattern, then, that sticks doggedly to the mould is worth one's attention during its exhumation—from the point of view of "what *not* to do." Here the patternmaker becomes an interested spectator. To stand by, sheepishly impotent, conscious that he is responsible for the mess, as mould eruption follows the small-scale earthquake, is an experience calculated to awaken the patternmaker's sympathy for the moulder; to develop his foundry sense; haply, to extend his vocabulary; and, generally, to accelerate his education!

Early Lessons

The author vividly remembers one of his first lessons on "how *not* to make a pattern"—although it occurred over forty years ago. In this case, the pattern (it is only fair to remark) was supplied by an outside firm, and was in the nature of a bedplate, measuring about 7 ft. by

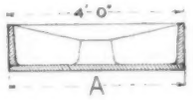

FIG.1

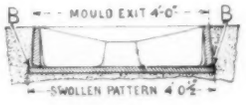

FIG.2

4 ft. and 12 in. in depth, as moulded. The pattern had been rammed up in the mould, and preparations were in hand for its withdrawal. After several men had exhausted all their available energy, applied in every available manner, in an attempt to separate mould and pattern, and the foundry manager (the author's father, by the way) had arrived at the last shred of his patience, an overhead crane finally exhumed the "body"—more or less dismembered. Needless to say, the mould—or, rather, what was left of it after the outrage—was useless!

Such a lesson could never be forgotten. The trouble originated in the improper construction of the pattern—a cross section of which is shown in Fig. 1 as moulded, that is, table-side downwards (to secure a clean machining surface). The bottom plate, A, had been glued together as one piece, with close joints, and allowed to extend the full width of the job. Then the varnish was deficient in shellac. Here was just the ideal combination of bad practice to create mischief. No provision whatever had apparently been made for combating the influence of mould moisture. The damage would not have been so great had the sides of the pattern been allowed to extend the full depth of the job. This, at least, would have prevented the "step" effect of the protruding base plate. Moreover, the pattern would have been, as a whole, far more moisture proof if it had been given, say, two coatings of really good shellac varnish, instead of the single-coat "make-believe"!

After a night in the damp mould—or (memory fails on this point) it may have been all the week-end (a very objectionable practice when it can be avoided)—the plate expanded. Glue and brads (screws were nowhere to be seen), which before contact with the mould, had kept the plate flush with the outside of the frame, proved ineffective against the superior force of mould moisture. The lower part of the mould was forced outwards, and the plate itself projected quite enough to ensure that pattern and mould would never part company—on peaceful terms! Fig. 2 shows the pushed-out sides (slightly exaggerated for purposes of illustration) and the projecting plate, B. The lesson might be stated as the second rule of patternmaking: A pattern should be constructed in such a manner as to render negligible the influence of mould moisture.

Inverse Seasoning

The above rule is based on the well-known natural phenomenon of shrinkage across the grain that timber undergoes as its moisture evaporates when exposed to drying conditions. Well-seasoned timber, of course, is usually employed for patternmaking. It should be kept in mind, however, that a pattern is not a piece of furniture, but a moulding agent, and, as such, it is brought into close contact with moist, and even steaming-hot sand, in which it may be buried for several hours, or, in the case of a large pattern, for some days. Then, as moisture is re-absorbed through the pores of the wood, the action of seasoning is reversed, and the timber tends to *expand* across the grain.

It follows that the more carefully seasoned the timber employed in a pattern, the greater the need for anti-growth measures in construction. Of the various methods practised to achieve this end, the principal are:—(1) The "open joint," which localises any expansion or shrinkage that may occur, and leaves the overall dimensions practically constant; (2) the outside frame with panelled centre, which also remains constant under extremes of drying, and moisture-saturating conditions, and (3) segmental construction. This latter method is of almost universal application. It is simple, as well as reliable. By glueing together a number of pieces of wood (segments) in such a manner that the straight, stable grain of one piece is utilised to correct the possible warping tendencies of its neighbours, an interlocked, dependable whole is secured. In this way almost every conceivable shape—minute or gigantic, multi-angled or polyplaned—can be made to "stay put." The corrective interaction of a multitude of segments neutralises potential evils and produces a reliable structure.

Pattern Usage

Here, the author begs leave to digress, for a moment, from "Patternmaking" to "Pattern usage." It is one thing to make a pattern proof against normal mould humidity, but an entirely different matter to render it invulnerable to every form of moisture attack—for instance, the moulder's water pot! Admittedly, mould joints may need a little extra moisture bond before the pattern is withdrawn. Granted, too, that the moulder can scarcely be expected to realise (as the patternmaker naturally does) the deleterious effect upon the joint of a pattern (sparingly varnished, as a rule), or on the light-plate type of construction, of repeated "shower baths"!

Consider for a moment this baneful practice. The water—under pressure, as it is flung from the water brush—is driven into the exposed crevices, and percolates, more or less, into the interior recesses of the pattern, where it devitalises the glue, and gives rise, sooner or later, to the disintegration of the whole structure. The author feels constrained, therefore, naturally with the utmost diffidence, to suggest a warning on this point for the guidance of the moulder who would have his pattern retain its original

* A Paper read before the Birmingham Branch of the Institute of British Foundrymen, Mr. E. Thomas presiding.

state of perfection. The warning would be most effective, of course, if it could be made to issue, at the appropriate moment, gramophone-fashion, from the pattern! If this be found inconvenient (and the author must confess he has not yet managed to try out the method), the warning might be clearly inscribed on the joint, or the plate of the pattern, so that, as the moulder was about to apply the cold douche, he would read: "*Don't water the pattern; it is not a garden plant!*"

The importance of Rule No. 2 is further exemplified in the following case, where inattention to the rule led to the depreciation, in less than a month, in the value of a pattern, from thirty pounds sterling—its cost, to thirty pence—its sale price as scrap!

Learning from Experience

Upon taking charge of a pattern shop, some years ago, the author found, in course of construction, a platform pattern, nine feet by eight feet, with a panel three-quarters of an inch in thickness. The panel was formed of two- close-jointed, mahogany slabs of equal thickness, with the grain of the wood on one side running at right angles to that of the other, the whole being securely screwed together. It was immediately obvious to the author that this attempt to defy natural law would prove abortive. As the pattern was nearing completion, however, he decided to allow this gross error of construction to demonstrate its own unworthiness. The slight additional cost it was felt would be amply justified in the accelerated education of all concerned.

No finer lesson could have been staged! It should be noted that the pattern was required to be in service almost continuously. This meant day-after-day subjection, for several hours, to the expansive influence on each side of the plate of the moist and more or less steaming sand. This expansive action, moreover, on account of the grain of one side running at right-angles to that of the other, was similarly right-angled in its operation, on the respective sides of the plate. Imagine the effect: Nine feet of well-seasoned mahogany tending to expand across the grain against the restraining force of the length-wise grain of another piece, which, in turn, tends to extend its eight feet of cross-grain whilst remaining constant in length! The result was tantalising to the moulders. Increasingly charged with moisture, the flat plate rapidly assumed a kind of saucer shape.

Now, moulders have certain, coercively-persuasive methods of dealing with refractory patterns. Usually, the pattern succumbs to the treatment. That the patternmaker does not always agree with this treatment is beside the point—it secures the desired result. In the case under consideration, however, the moulders realised they had caught a "Tartar!" Neither by coaxing nor coercion could the plate be induced to lie on the bed prepared for it. In vain, the moulders piled up 56-lb. weights on each corner. The plate won! As the weights were removed, it regained its self-determined, concavo-convex shape, with the resiliency of a laminated spring!

Consider the main essentials to be observed in making a reliable pattern of the above type. It is desired to produce a flat plate, 9 ft. by 8 ft. and ¾ in. in thickness. Now, a wooden plate of such an area and thickness is bound to sag, and, generally, to take the shape of the surface upon which it rests. It is not sufficiently rigid in itself to remain true without support (even if it were perfectly true to commence with), and one has to depend upon the moulder to strickle off a level bed upon which the pattern will be laid preparatory to the ramming-up process. It is important to note that since one is obliged to depend upon this bed to give to the plate its correct surface shape, it must clearly be a complete dependance. That is to say, the pattern will not only not be expected to possess rigidity, but must be constructed so that it cannot develop rigidity under any conceivable circumstances in which it may be placed in the foundry. To the end of its days, in short, it must remain as passive as a pancake.

Two Essentials

The two outstanding essentials, then, in a pattern of this kind, are: Suitable material and proper construction. If either of these factors be neglected, it matters not how carefully the pattern be made in other respects, or how accurate may be its dimensions; it is bound to prove, sooner or later, a complete and—as in the example referred to—a very costly failure. Furthermore, the loss may conceivably amount to many times the cost of the pattern. The probability being, of course, that the first two or three trial castings will measure up correctly.

FIG.3

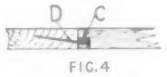

FIG.4

The foundry will then proceed full speed ahead. After this, the size of the scrap heap will depend upon the number of plates immediately on order, and the time that elapses before they are required in the assembling department! (This points to the advisability of an occasional inspection of patterns in constant use. Here, "out of sight, out of mind" sometimes proves to be an expensive attitude.)

Now, since the plate under consideration is intended to be a "standard" pattern, that is, one which will be in constant use, durability should be secured, as far as possible. The term "as far as possible" is used advisedly; it must be durability, plus reliability. One might employ mahogany, for instance, which is much harder, and consequently more durable than yellow pine. Its very strength, however, fatally militates against its adoption in certain situations. Where it is inclined to warp, especially if it has wide, exposed surfaces, the absorption of moisture renders it (as was shown in the case mentioned) completely intractable. Yellow pine will not wear so long, but by a suitable

FIG.5

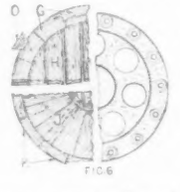

FIG.6

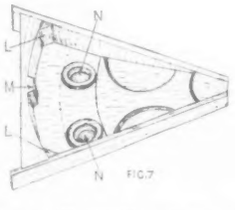

FIG.7

arrangement of grain it will remain true to its original shape until—like Oliver Wendell Holmes' "One-Hoss Shay"—it goes to pieces all at once, by senile decay!

Here one is faced with the direct question: Should the pattern be constructed of a material which is exceedingly hard and durable, and which may permit of, say, three thousand castings being made before it is worn out, but which, on account of its inherent tendency to warp, may become quite useless before three castings have been made; or, should a lighter and milder material be used, of admittedly less durability, but upon which one can rely for, say, one thousand castings? Well, patternmaking is not gambling; it is a scientific, creative art. Pine (*pinus strobus*) should, therefore, be employed for the body of the pattern, at least, because, whatever may be its potential refractoriness, as pine, it is possible, by appropriate methods of construction, to keep it under complete control.

Type of Construction Necessary

What form of construction is likely to prove most reliable in this case? It has been previously mentioned that timber is not affected by moisture length-wise of the grain. This is the key to the situation. The construction of the pattern should be such that the length-wise grain of the timber permanently controls the overall dimensions of the plate, whilst eliminating, or at least overcoming, whatever warping tendency may be present.

Now, a "framed-up" structure, as shown in Fig. 3, completely satisfies these conditions. The whole of the ground work is of yellow pine. The outside frame, with "half-lap" corners, is stiffened by the centre cross, which is "half-lap" dovetailed, and securely screwed into the sides and ends of the plate. The remaining spaces are closed in with open-joint panels. The ends of the panels, it should be noted, are rebated down to fit on a mahogany strip of ⅜ in. square section. This strip is glued and well nailed along the inner edges of the frame, as seen in enlarged section at C, Fig. 4. The hardwood strip, of course, obtaining support from the body of the frame by the long nails, D, is more dependable than the yellow-pine lip would be, rebated on the inside of the frame.

With a foundation of yellow pine, one may safely employ mahogany for the superstructure. Such harder, closer-grained material is less vulnerable to those ultra-vicious vent-wire stabs, and the concussive effect of misguided rammer blows, for which the salient features of a pattern seem to possess a sort of magnetic attraction! Since the width of these mahogany trappings, again, is comparatively small, the deleterious effect of any potential warping tendency on the part of any piece, that is not locally nullified by a complementary tendency on the part of an adjoining piece, may be regarded as negligible. In a word, one should make the most efficient use of the length way of the grain (upon which one may implicitly rely), whilst keeping the width of every piece in the structure within manageable bounds.

Quite an appreciable advantage of the above method, from the foundry point of view, is the entire absence of battens which are required to hold the plate together with the frameless method of construction. Such battens, moreover, in this class of work, would need to be in the top-part box, since stopping-off would deface the surface.

Making Large Circular Plates

Large circular plates may also be constructed on the foregoing plan. In these, however, instead of the outside frame being "halved" together (which, of course, is feasible), a ring is built up of segments, and the centre panelled as before. Any deviation from the single-plane plate usually necessitates a corresponding variation in the construction of the pattern. An example of a plate pattern, which was actually required to be concavo-convex in form, is illustrated in Figs. 5, 6 and 7. This plate is 3 ft. 6 in. in diameter, with a ⅜-in. panel. It has seven 6-in. dia. holes midway between the outside and the centre of the pattern, and fourteen small-diameter holes near the rim. These are shown in the right-hand half plan of the casting, Fig. 6.

Now, it would be absurd to expect such a flimsy pattern—made, that is, exactly like the casting—to remain true whilst being rammed up in the mould; some sort of external support is imperative. Admittedly, a metal pattern might be employed, if sufficient castings were on order to justify the expense. Even then, a wooden pattern would first be necessary. Here, one must

resort to the patternmaker's well-known "catalytic agent"—his Open Sesame in all sorts of construction and moulding problems—the coreprint. By the employment of segmental cores, as shown in dotted section, at E, Fig. 5, a reliable working pattern may be produced, which, with fair treatment, should last for at least a thousand castings.

As will be seen in Fig. 5, the annular coreprint extends well over the edge of the pattern (at least 2 in.), and serves as the outside bearing for the cores. The fourteen round cores—which are formed on the main cores—are positioned by long well-tapered coreprints—F, Fig. 5—on the under side of the pattern, as moulded. The seven 6-in. dia. holes in the web of the casting—which, fortunately, provide further bearings for the main cores—are formed in the corebox, Fig. 7. It should be noted that the radial joints of the cores pass through these large holes. This reduces fettling: it eliminates the possibility of fin to the extent of the diameter of the holes. The small, outer holes, positioned in the centre of their respective facings in the corebox (which forms the upper surface of the casting), and located by the coreprints, F, emerging from the centre of the facing on the lower side of the pattern, ensure the absolute accuracy of each facing over its counterpart.

The construction of the pattern is featured on the left-hand half of Fig. 6. The upper quarter refers to the top side, as moulded—E, Fig. 5. A double row of segments, G, forms the outer ring, which is rebated on the inside to receive the open-joint panels, H. This ensures an unshrinkable and unwarpable foundation. Stiffening is secured by superimposing a layer of radial segments, J, seen in the lower left-hand quarter of Fig. 6. It should be noted that the radial segments do not extend to the periphery of the pattern. Their perimeter is bounded by annular segments, K. This is a refinement in construction (perhaps not of vital importance), intended to seal the absorbent end-wise grain from moisture attack. It also confers a better moulding surface on the edge of the coreprint.

Two features in the corebox, Fig. 7, deserve notice: the flats, L, and the locating piece, M. Now, in a so-called theoretical arrangement of the job, these pieces are quite superfluous. One might assume, apparently by unshakeable logic, that perfection would be attained if the outside coreprint end of the corebox was made exactly one-seventh of the periphery of the pattern, and the small holes in the corebox were arranged to form long, tapered pins on the core, of the required relationship with each other, and with the coreprints on the pattern. The moulder would then merely need to position the cores in the mould, one after the other, replace the cope, and cast the job.

A Perfect Defence

This mode of reasoning is very common. It is also very expensive; for it is a prolific source of scrap—and the foundry pays! The patternmaker, of course, easily exonerates himself. There appears to be no answer to the specious argument that he has worked to contraction rule and blue-print. He proves, by means of templates, that pattern and corebox possess the required relationship with each other. The moulder may sense injustice, but cannot prove it. The evidence against him is too damning. The scrap is there; and the pattern measures up to blue-print quite correctly. Nevertheless, the patternmaker is either very inexperienced, or dishonest, with himself, if, though proved innocent, he does not feel, to some extent, guilty! The author cannot deny that, on more than one occasion, his reluctance to reverse a verdict given in his favour has over-ruled his hatred of moral cowardice!

The plain truth, which cannot too often be reiterated, is that any theory of pattern arrangement which leaves out of account relevant foundry practice is fundamentally wrong in principle. Sound logic (as Dr. Johnson would say) primarily implies sound premises. Accuracy, and perfect agreement of pattern and corebox are not, in themselves, reliable criteria of first-class patternmaking. Before the core is finally housed in the mould, it must be made, removed from its corebox, dried and positioned. And before the mould can receive the core, the pattern must be withdrawn. Now, unless these essential operations are intelligently anticipated by the patternmaker, various interferences may creep in "like a thief in the night." The result may easily be complete chaos! And this in spite of—indeed, perhaps on account of—a too-exclusive attention to dimensional accuracy to the neglect of foundry requirements. Hence, accuracy, *per se*, is not sufficient. The goal to aim at is that optimum arrangement of pattern and corebox which "locks, bolts and bars" against operation interferences.

In the case under consideration, the acute angles of the corebox (that is, minus the pieces L)—in conjunction with the sides of the box unavoidably deficient in taper—do not conduce to easy core withdrawal. This means the possibility of core distortion. The pieces L eliminate the offending corners without materially detracting from the bearing of the core in the coreprint. Such corners, moreover, are well tapered.

The block, M, again, provides a core location that can be kept in view. For the projecting "dowels" of core, formed by the small holes, N, Fig. 7, prove in practice (with apologies to G. K. Chesterton) to be locations that cannot be located! It would be found that, as the core is being placed in the mould, the outside, overhanging coreprint, seen in Fig. 5, shuts out the view of the small projecting cores before they enter the impressions formed by the coreprints, F. The outer edge of the coreprint, E (Fig. 5) is recessed to correspond with the space left in the core by the block, M. As a further aid to accuracy, hardwood blocks are supplied, shaped to fit the recesses, but sufficiently deep to be securely gripped by the outside of the mould, as seen at O (Fig. 6). These are also made, say, 2 in. deeper than the coreprint, and serve as more reliable guides than green-sand cores.

Plywood as an Asset

Before taking leave of the construction aspect of patternmaking, a passing reference should be made to plywood. No one needs to be reminded, of course, that plywood does not shrink. This is a valuable asset in patternmaking. One may use it (as the author regularly does) in widths, say, up to 3 ft. and over, without fearing any variation of dimensions. This could not be done with ordinary wood. The fact that it may be obtained in sheets of from slightly under $\frac{1}{8}$ in. to $1\frac{1}{2}$ in. in thickness, combined with an unvarying thickness-dimension of each sheet, makes it a very useful auxiliary in patternmaking.

An auxiliary, however, is not a panacea. Plywood is no cure-all. To be useful, it must be understood. And real understanding comes, mostly, from experience. "Plywood is of no use for patternmaking!" said a patternshop manager to the author some time ago. Naturally, the author then asked his friend if he had given it a trial. The answer was a contemptuous "No!" Such an attitude is not, perhaps, uncommon. Yet it is neither scientific nor justifiable. Plywood, of course, has its weak points; but these, when known, may be avoided. It does not take very long to discover that, although plywood does not shrink, it may warp. Even the 1-in. gauge material (made up of seventeen laminations), given a sufficient width, or unevenly exposed, might, conceivably, deviate to some extent from the plane truth, if allowed time unlimited to imbibe mould moisture.

Education here, as in the art and craft of patternmaking generally, is largely a matter of inductive reasoning from experiment and observation. An occasional mistake is the best tutor! In this way, the enterprising patternmaker learns just how far plywood may be trusted. It is difficult to formulate rules for universal guidance, since patterns vary so widely in shape and dimensions. One may safely use plywood, however, where the general structure of a pattern is sufficiently rigid to neutralise whatever warping tendency may be present. As a "drum-head" connecting medium, plywood excels. It does not develop "shakes"; it has no open joints to annoy the moulder with loose sand as he withdraws the pattern; and its multiple cross-laminations invest the wide sheet with a "mild-steel" tautness quite unattainable with ordinary wood. To the conservative patternmaker, then, sceptical as to the serviceability of plywood, the author's advice is: "Try it."

Application of Plywood

A typical example (from actual practice) of the employment of plywood, in a "drum-head" capacity, is illustrated by Fig. 8. This represents the general structure of a shute pattern, 3 ft. wide by 4 ft. long. The finished pattern contains other members, which are omitted from the sketch for the sake of clarity. The job was first marked out on a sheet of plywood, $\frac{3}{8}$ in. in thickness. This was cut to shape, and securely glued and screwed to the outside frame—which had been separately constructed. As will be gathered from the sketch, such a framework possesses sufficient rigidity, in itself, to nullify any possible warping tendency on the part of the plywood. The main purpose of the plywood is that of a general connecting medium, which can be relied upon to keep the overall shape and dimensions constant.

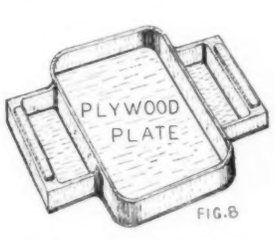

FIG. 8

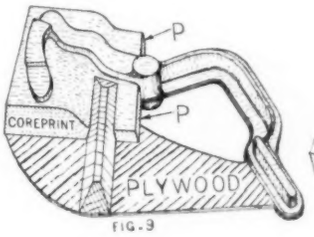

FIG. 9

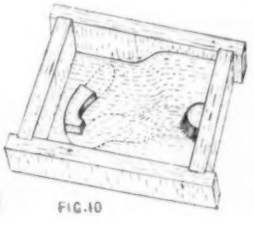
FIG. 10

The fact that plywood has no weak "short grain" is a strong argument for its employment in such patterns as that shown in Fig. 9. It will be seen that this component lies in two planes. The connection (merely the small-diameter boss) between these planes is so frail that to attempt to make such a pattern exactly the shape of the casting would be to court disaster—probably before the pattern reached the foundry, and, certainly, before it had been withdrawn from the mould. Frailty is converted into strength, however, and moulding is simplified, by the employment of the coreprint, P (the corebox for which is seen in Fig. 10).

Here, again, plywood forms an ideal foundation. The various centre lines are marked on the non-shrinkable plate, and the job built up on it. When this point is reached, it pays to "hasten slowly." The immediately obvious thing to do is to trim the plywood round to the shape of the pattern. But the obvious, here, is not advisable.

A pattern is essentially a moulding tool. As a tool, its serviceability must ever take precedence over its rank as a "work of art." To

(*Continued on page* 133.)

XUM

Induction Melting Furnaces*

REVIEW OF MODERN TYPES

Channel-Type Induction Furnaces

The first furnace of this type to be developed possessed a horizontal ring-shaped channel which was the short-circuited secondary of a static step-down transformer. Although it preceded the arc furnace in its commercial introduction, it has now been almost entirely supplanted by the coreless induction furnace, or the arc furnace. A variation of this type of furnace embodying radical modifications in design, and known as the Ajax-Wyatt furnace, has found a wide application in the non-ferrous industries, particularly for the melting of brass and nickel-silver. In point of fact, probably 90 per cent. of the world's output of wrought brass is melted in this type of plant. It has been used with some success in Germany for the superheating of grey cast iron. When charged with cupola metal of an average temperature of 1,350 deg. C. it will superheat this to 1,550-1,600 deg. C. with a consumption of only 60 units per ton, which is only 60 per cent. of that required for doing the same duty in an arc furnace. It has limitations as regards refractories, as the channel in which the heat is induced is a narrow submerged slot which merges into an overlying pool of metal. The slot is complicated in form and there is little thickness between the metal and the primary coil. A fritted quartzite lining was used for cast iron and the life obtained was one month's continuous operation.

Coreless Induction Furnaces

This type of furnace is notable for the reversion to the crucible form of bath, with its many attendant advantages, amongst which may be mentioned the flexibility resulting from being able to change the composition of alloy from melt to melt, the accessibility of the bath, and small surface area for radiation for a given weight of melt. This type of furnace was originally operated at comparatively high periodicities, the frequency change being effected by means of a Tesla oscillatory circuit. The circuit comprises a step-up transformer, the output voltage being of the order of 6,600. This charges up a bank of condensers which are discharged through a mercury spark gap, the current being fed to the inductor coil and producing an oscillatory current in the region of 20,000 cycles. Expansion beyond 20 kw. was not convenient or economical with this equipment, so that the application of this type of plant was limited to a melting capacity of about 20 lbs. Slightly larger furnaces giving an output of 60 kw. with a rotary spark gap have been used, but they are noisy and by no means convenient to operate.

The small spark-gap furnace referred to has become a most valuable tool for research work and is possessed by almost every research organisation and university. It lends itself admirably to vacuum melting or to fusion of metals in controlled atmospheres. It is used commercially for the melting of metals of high melting point, such as platinum and its alloys, tungsten carbide, osmium-iridium alloys, etc. It should also be mentioned that furnaces provided with a thermionic-valve frequency changer are also in use for laboratory work.

It was later found that for large furnaces frequencies of the order of 20,000 cycles were neither necessary nor desirable, and rotary machines could generate from 500 to 3,000 cycles. As a testimony of the reliability of these motor-generator units it may be noted that the first furnace installed for steel melting has been in almost continuous operation for six years without any serious mechanical or electrical breakdown. The furnace unit is simple in construction, and a notable feature is the small weight of refractory material. For instance, a 30-cwt. furnace contains only 300 lbs. of refractory. This makes it ideally suited to intermittent working, and as the furnace can easily be emptied completely after each heat it is amenable to working successive charges consisting of different mixtures.

The electrical equipment consists of a motor-generator set, which may be located if desired in a substation at a distance from the furnace and operated by remote control. The furnace presents a highly-inductive load, the power factor being 0.08 to 0.1, so that a bank of condensers is provided to raise the power factor to unity on the generator side. As the electrical and magnetic properties of the charge vary during the period of heating, the condenser bank is arranged so that the capacity may be increased to compensate for the wattless current throughout the heat. This is done by dividing the bank into two sections, one being permanently in circuit, while in the variable portion condensers may be switched in by the operator by means of contactor switches. This operation can also be effected automatically. Where several furnaces are connected to a single generator, this latter feeds the current to common busbars and the voltage on each inductor coil (which regulates the input of energy) is altered by means of an auto-transformer, or the inductor coil may have tappings on it and therefore function itself as the auto-transformer. Where a single generator energises one furnace unit a more convenient form of load regulation is employed, namely, controlling the field current by means of a rheostat mounted on the control panel.

There has been much controversy regarding the most suitable frequency. The power liberated in a metallic charge is directly proportional to the frequency, so that if a low frequency is employed a large number of ampere turns has to be employed to give a required input. This entails a considerable amount of stirring and also greater losses in the inductor coil. On 50 cycles the mechanical motion of the metal is so violent that the charge tends to assume a spherical form and hardly makes contact with the walls of the bath. For melting small pieces, especially such materials as nickel shot and sponge iron, a comparatively high frequency, *i.e.*, 960 cycles or more, is almost essential to rapid melting. When frequencies approach normal, melting can only be effected with charges consisting of very large lumps of material. Industrially these low frequencies have only been used for superheating liquid charges or for maintaining the temperature of the metal such as when the furnace is used as a ladle. The majority of furnaces operate at 1,000 to 2,250 cycles, which has been found convenient and economical. It should be mentioned that the reduced cost of generators for the lower frequencies is more than offset by the increased cost of the condensers.

"Pinch Effect"

The stirring motion imparted to the metal in the coreless induction furnace is probably its most important feature from a metallurgical viewpoint. It is caused by two distinct effects: (*a*) The mutual attraction of the primary coil on the metal; (*b*) the attraction of the current-carrying elements in the bath—which is called "Pinch Effect."

The intensity of stirring can be controlled within wide limits—in the first place by altering the electrical centre of the coil by the insertion of reactances between upper and lower sections, and secondly by controlling the power input.

This stirring motion in a vertical plane effectively ensures assimilation of alloy additions and guarantees absolute homogeneity in the melt. This is of extreme importance in certain tool steels containing tungsten, where gravitational segregation is prevalent. As a test of the efficiency of the stirring, a melt of high-speed steel was made by inserting the tungsten in the bottom of the crucible, and the resulting ingots showed no perceptible difference in composition in samples taken from upper and lower portions of the ingots, no mechanical stirring being used.

It has been demonstrated in actual production tests that the swirling of the metal assists in obtaining during refining a phenomenally-rapid removal of phosphorus, carbon and sulphur. For instance, a phosphorus content of 0.15 per cent. can be reduced to 0.015 in 6 min., and a carbon content of 2.0 per cent. brought down to 0.1 per cent. in 25 min. Elimination of sulphur presents a little more difficulty. It can be brought about by using a fluid lime-fluorspar or lime/calcium-chloride slag, but this is severe on the refractories. By the cautious addition of spar 0.06 per cent. sulphur can be easily reduced to 0.025 per cent. without excessive wear. In a certain works, merchant scrap was melted under a lime slag without intentional refining, and the analyses before and after averaged as follow: before (and after), sulphur, 0.05 (0.025); phosphorus, 0.05 and (0.02) per cent.

The stirring of the charge has not been sufficiently exploited or studied in relation to the deoxidation and clarification of steel from non-metallic impurities. It cannot be questioned but that the rapid motion of the metal tends to bring suspended inclusions, resulting from the addition of deoxidants, into intimate contact, thus promoting coalescence which assists in their removal by gravitation. But more important is the possible use of slags of a higher surface tension than the inclusions, which will be brought successively into contact with this slag. This motion also holds out the possibility of using slags out of equilibrium with the melt, which, in accordance with the partition law, will give up its oxygen content to the slag as FeO and MnO. The effect of stirring is to increase enormously the surfaces of contact between slag and metal and to reduce the time factor in deoxidation processes. This type of induction furnace has also been used recently with a considerable measure of success for treating melts with gases, and in this way it has been possible by the use of hydrogen to eliminate carbon from stainless steels to the extent of obtaining a content of 0.02 per cent. This will probably prove the much-sought solution for weld decay in 18/8.

For the melting of alloys requiring an exceptionally low carbon content, such as permalloy and mumetal and also nickel-chromium alloys, it has proved invaluable. Moreover, it has solved the problem of the reclamation of stainless and other high-alloy steel scrap which can be melted without carbon pick-up and with an exceptionally-low loss of alloying elements. In this connection the following figures will probably be of interest. An alloy-steel charge analysed, as follows, before melting (per cent.):—W 8.5, Cr 0.8, Mn 2.25, Si 0.66. An analysis of the cast gave (per cent.):—W 8.2, Cr 0.75, Mn 2.1, Si 0.66. Another example was as follows (per cent.):—Charge (and cast): C 1.16 (1.04), Cr 0.63 (0.63), Mn 1.8 (1.25), Va 0.3 (0.25).

Lining Methods and Materials

Almost all successful linings are of the monolithic type, and they all should possess a backing of loose refractory. The important function of this layer of unbonded or unfritted refractory is that it acts as a barrier against the penetration of molten metal if a crack occurs on the inner surface, while it also serves to accommodate volume changes in the lining by virtue of its "resilience." Moreover, it acts as a thermal insulator. The lining proper may be made *in situ* by the Rhon fritting process, in which a

(*Concluded on page* 139.)

* Extract from a Paper on "The Electric Melting and Heat Treatment of Iron and Steel," read before the West of Scotland Iron and Steel Institute by Mr. A. G. Robiette at Glasgow recently.

Proposed Degree Course in Foundry Science

PARTICULARS OF THE COURSES AT THE UNIVERSITY OF SHEFFIELD

It is proposed to inaugurate three distinct courses in foundry science; firstly, an honours course of four years' duration, resulting in the degree of B.Met. (Founding) (Hons.). The first two years of this course will be occupied largely with the theoretical and practical study of chemistry, physics, mathematics and physical chemistry. In the second year, general metallurgy and elementary metallography will be included. In the third and fourth years, the Michaelmas and Lent terms will be taken up with the theoretical and practical study of subjects bearing particularly on foundry practice —iron and steel and non-ferrous—special attention being given to experimental work in the foundry. During the summer term, including one month of the long vacation, students will be placed in an actual foundry with a view to gaining works' experience.

The foundry courses held at the University will include, amongst other things, theoretical and practical treatment of foundry methods, moulding, coremaking, patternmaking, sand testing, the making of castings, fettling and the heat-treatment of castings, etc.

Secondly, there will be an ordinary degree of B.Met. (Founding) occupying three years. The first year will be the same as that for the honours course. The second year's honours course, however, will be largely omitted from the ordinary degree course, and, whilst certain of the advanced courses will also be omitted, the practical works experience in the last two years will be included.

For those students who have not passed the matriculation examination, an associateship course will be held, similar in all respects to the ordinary degree course.

Experimental Foundry Equipment

A model foundry is already partly established in the Department of Metallurgy, and it is hoped that promises of further plant kindly offered by the industry will, in the course of six months or so, enable the Department to have at their services the finest-equipped experimental foundry in Great Britain.

Finance

A minimum of £1,500 per annum is required to commence the course, and it is hoped that more than this sum will be volunteered by the industry. Whilst the initial expenditure will depend largely upon the amount available, the following details give approximately the essential requirements:—

Principal lecturer in founding, £450 to £500 per annum.
Services of a practical foundryman, lecturer on sands and refractories, existing staff in Metallurgical Department, £700 per annum.
Secretarial work, £150 per annum.
Purchase of materials, £150 per annum.
Total, £1,500.

It will be realised, however, that the sum of £1,500 is a bare minimum, and that any addition to this will render a more efficient working of the scheme. If the necessary finance be obtained immediately, it is proposed to begin the scheme next session. The amount assigned for the purchase of materials is obviously rather lower than desired.

The University would require guaranteed subscriptions for seven years, after which it is hoped that the scheme would be so successful as to merit a continuance of support from the industry.

The Institute of British Foundrymen has closely examined the scheme, and is of opinion that it provides a course of training of university standard in foundry science which is absolutely necessary in order to provide the industry with trained personnel.

The Institute of British Foundrymen cordially endorses the proposals of the University of Sheffield, and is giving those proposals its fullest support. A committee appointed by the Institute is taking an active part in the organisation and inauguration of the scheme and in enlisting the financial support of the industry.

The British Industries Fair

BIRMINGHAM SECTION

While the official catalogue has innumerable groups and sections, from the foundry point of view the matter is much simpler. There are four groups: (1) Foundry products; (2) raw materials and machines connected therewith; (3) sheet-metal products; and (4) machine processes and raw materials used in the industry. The last two sections serve to illustrate the competition from other types of manufactures. Thus founders can examine gutters, baths, saucepans, kettles and stoves made from material other than castings.

Foundry Products

Perfection in surface conditions of grey-iron castings is to be seen on the stand of John Harper & Company, Limited, of Willenhall, due to their metallurgical control and the lay-out and organisation of their fettling shop. An exceedingly high standard has been achieved by many other exhibitors, notably Qualcast, of Derby; Revo, of Tipton; and the various Falkirk firms. Stanton are showing the road setts which they are making at their Holwell plant for the Mersey Tunnel. The wearing surface carries a sulphur hardness. Leys have an exceptionally fine stand to display their equally fine malleable castings.

Foundry Plant

The only stand exclusively devoted to foundry equipment is that of Pneulec, Limited, of Smethwick; they show a full range of magnetic and pneumatic moulding machines, the Pneulec Royer, modern sand mills, Overhead sand equipment and a cupola. It is a well-organised stand and certainly should be inspected by all founders. The V.S.K. sand-conditioning machine, which is much esteemed by Continental foundrymen, is now being made in England by W. C. Holmes & Company, Limited. It is being shown on their stand in two sizes—five and eight tons per hour. As it is also used in the gas industry for oxide breaking, its robustness for foundry use is assured.

The cleaning of sand is becoming more and more appreciated each day by the foundry industry, and two firms specialising in this line, Rapid Magnetting Company, of Lombard Street, Birmingham, and Electromagnets, Limited, of 2, Church Street, Birmingham, have stands. We are looking forward to the time when no foundry will be without its magnetic separator, as it is now becoming apparent that cleanliness is next to godliness in the matter of moulding sand.

Raw Materials

It might be worth while, as no better occasion exists, for founders to examine the question of heat-treatment of castings while they are at Birmingham, as the British Commercial Gas Association has within its organisation a wealth of information on this subject. Gibbons and Steins have stands where problems concerning refractory materials can be discussed. The refractory industry is just now particularly interested in the question of cupola linings, since the recent meeting of the Ceramic Society, when Mr. Green opened a discussion on the subject.

The pig-iron industry is represented by Staveley, Stewarts and Lloyds, Stanton, Sheepbridge and United Steel, and technicians are available to advise foundrymen as to the potentialities of their various qualities.

One stand, which founders must on no account miss visiting, is that of the Bureau of Information on Nickel. Here Dr. Everest and his colleagues will give all the latest information about the achievements of alloyed cast iron. This development is growing so rapidly that it would be difficult to keep oneself properly documented but for the excellent service given by the Bureau.

Another exhibit of a similar character is that of High Speed Alloys, Limited, where information about molybdenum cast iron may be gleaned. This element has made some real progress in recent months, and founders have in this stand an opportunity to evaluate its worth from their particular angle.

On the stand of Imperial Chemical Industries, Limited, there is shown a new copper alloy, sponsored by I.C.I. Metals, Limited. We have not yet personally investigated Kunial Brass, as it is called. The properties as set out in the pre-exhibition notice all referred to the wrought condition. There is a series of heat-treatable alloys, which can be hardened to give a diamond hardness figure of 240, associated with 485 tons tensile and 11 per cent. elongation. This alloy contains 72 per cent. copper.

There are not many exhibits of interest to the patternmaker except that of the Dominion Machinery Company, of Hipperholme, and that of the various Sheffield firms which make saws and hand tools.

On the British Oxygen Company's stand visitors may see equipment for welding, cutting, dissolved acetylene lighting and metal spraying. In addition to standard types of equipment for oxy-acetylene welding and cutting, new applications are shown, including the vacuum type dissolved acetylene economy regulator, for use in scrap cutting yards; a new two-jet welding blowpipe; and a double bevel cutting attachment. A grooving cutter for removing cracks, slag inclusions, etc., from steel plate, blooms or ingots, and a range of ferro-arc electrodes are also shown.

For the fettling shop, there is a range of portable tools shown by F. Gilman (B.S.T.), Limited, of Birmingham, and no doubt, if one has the time, a new source of supply for buckets, riddles, spades and shovels and other loose tools might be discovered. It must be remembered, however, that it takes three days to work the Fair systematically; that it is not easy to have accommodation in Birmingham; that one can count on seeing some friends who will take up a certain amount of time. Thus it means for the average visitor that he must "work" the exhibition in a few hours. Therefore, we counsel our readers to make up their minds which stands they intend to inspect before leaving home, procure a catalogue, work out a tour, and, if there be any time left, they will find, as we do, that the Fair is extremely attractive, educative and interesting.

Patternmaking

(*Continued from page* 131.)

trim the plywood neatly round to the shape of the pattern might improve its appearance as a work of art, but would considerably detract from its value as a moulding tool. It would rob the pattern of much available strength—literally, of its built-in backbone. Since the plywood forms part and parcel of the structure, then, why not allow some of it to remain as a connecting piece between the weak, outlying limb and the stout coreprint—similarly as shown in Fig. 9? The core automatically stops off one end of this connecting piece, along with the stiffening batten, and the moulder makes short work of the other end. It is understood, of course, that if many castings were required a metal pattern would be made.

(*To be concluded.*)

Steel Manufacture in the Transvaal

SPECIAL REFERENCE TO HIGH-GRADE STEELS

In the course of a Paper in the "Journal of the Chemical, Metallurgical and Mining Society of South Africa," on the "Manufacture of Drill and Other High-grade Steels at Vereeniging, Transvaal," by DR. J. H. DOBSON, G. ROBSON, J. B. BULLOCK and H. CLARKE, the circumstances leading to the manufacture of high-grade steels at Vereeniging are recorded. It is pointed out that the mines of the Transvaal purchase each year about 6,500 tons of drill steels, valued at approximately £300,000. They also purchase close on £500,000 worth of rock-drill spares. Other extracts from the Paper are appended.

The first cast (in South Africa) of hollow-drill steel billets was successfully made on December 3, 1931, which day may, therefore, be said to mark the actual starting-up of this new enterprise.

Raw Materials.—The whole of the manufacturing processes involved in drill and other high-grade steels are concentrated at what is now referred to as the Wire Works of the Union Steel Corporation, which adjoins the works of Messrs. Stewarts and Lloyds of S.A., Limited, at Vereeniging. The basis of all steels made is scrap. The scrap-metal bins are arranged close to the furnace and each charge is prepared by filling a skid of adequate capacity and known tare weight from these bins, and adjusting the weight on an adjacent weighing machine. The 10-ton electric crane then dumps the skid on the charging platform between the two electric furnaces, with its outlet facing whichever is next due for charging. Dolomite is used for fettling and the other essentials for making a charge are lime, fluorspar, ferro-manganese, ferro-silicon, ferro-titanium, aluminium, anthracite coal, all of which are only required in small quantities, and they are drawn from their respective bins by barrow or bucket as required. It will be noted that the raw-material bins and stores are directly served by a railway siding.

FIG. 1.—VIEW OF FURNACES AND CASTING BASE-PLATE

Melting.—The furnace equipment comprises two 1½-ton three-phase Héroult furnaces, each supplied at 75 or 90 volts from a three-phase transformer of 450 k.v.a. capacity, with a supply pressure of 6,300/660 volts, 50 periods, fed by underground cable from the V.F.P. sub-station approximately 1,000 ft. distant. The higher of the secondary voltages is required for the melting-down period and the lower is used for the refining period. Each furnace has 6-in. electrodes, with water-cooled holders, motor-driven tipping gear, and a single charging door arranged to opposite hands to face the central charging platform. In front of each furnace outlet is a pit in which the slag or metal ladles are placed by crane.

The hearths of the furnaces are basic, being composed of dead-burnt dolomite mixed with tar and rammed into position and shape. The basic hearth and slag used give thorough control of sulphur and phosphorus content of the melt and records show many heats with these elements not exceeding 0.025 per cent. combined, and individual figures well below 0.01 per cent. When these furnaces are working regularly, the time taken from switching on the current to tapping out the finished charge is about three hours, and the time between taps is about 3½ hrs.

The furnace bodies are so designed that, by suitable lining, the melting capacity may be increased to two long tons, but 1½ short tons of molten steel only are required for casting a "plate" of hollow-drill steel billets as at present arranged.

A single-nozzle ladle with a capacity of 3 tons of steel, plus slag allowance, is used in tapping these furnaces, and drying of the ladle is done by gas near the producer plant at the opposite end of the works, a tramline being laid for conveyance of the ladles to and from the furnaces. Gas drying is, of course, both convenient and thorough, and always preferable where gas is available.

Fig. 1 shows the two furnaces, A and B, the skip in which the charge is weighed, and, in the foreground, a bare casting plate, before runner bricks or other equipment are assembled on it.

Casting.—The casting arrangements used for producing hollow-drill steel billets are the essence of the Gordon process. They are illustrated in Fig. 2, from which it will be seen that a circular cast-iron plate having six radial channels terminating at a central depression forms the foundation for the moulds. Each plate of 36 moulds requires approximately 2,800 lbs. of molten steel to fill it, and the product is 36 billets of 69 lbs., making 2,484 lbs. of product, the balance representing runners and the contents of the trumpet and feeder brick. Three plates are allotted to each furnace and each row of plates is set in line with the tapping spout of its furnace, so that the crane, having lifted the ladle out of the pit, has only to travel one way, no traversing being necessary.

Preparation for Rolling.—The reheating furnace, by the Dowson & Mason Gas Plant Company, Limited, of Manchester, is of the regenerative type. The controlled air supply is furnished by an electrically-driven fan, and is driven through chequerwork along the top of the furnace in counter-current to the exhaust gases, before being fed to the coal fire. A long luminous low-velocity reducing flame is obtained over the arch into the heating space and heat loss by scaling is thus reduced to a minimum.

An electrically-driven pusher gear is provided at the end opposite to the firegrate, and by means of it the billets are propelled down a sloping hearth, coming slowly from the cold to the hot end, and thus being raised very gradually to rolling temperature, which is in the region of 950 deg. C.

An electrical pyrometer, comprising a platinum/platinum-rhodium thermocouple and millivoltmeter, is provided to give a continuous indication of the temperature in the proximity of the billets at the point where they are withdrawn for rolling. The experienced roller can readily check the indications of such an instrument quite closely by the behaviour of the billet in the mill and by the fracture of the steel when rolled.

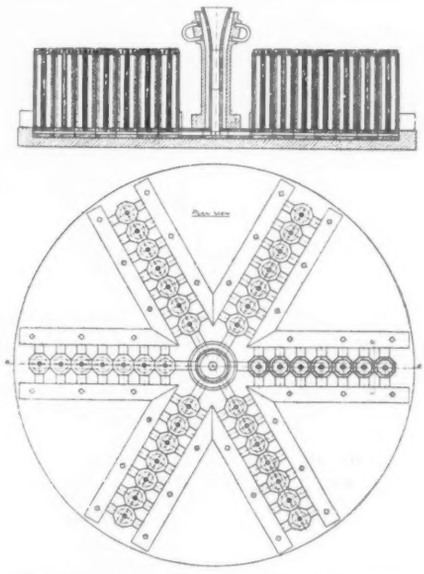

FIG. 2.—PLAN AND SECTION OF CASTING ARRANGEMENT.

Rolling.—The rolling mill in which the billets are reduced to the various sections of hollow-drill steel comprises five 12-in. stands, the first being two- or three-high as requisite and the remainder two-high. The mill is driven at 100 r.p.m. by a 350-h.p. 500-volt 3-phase 50-cycle slip-ring motor, running at 585 r.p.m. through steel reduction gear and pinion having a ratio 31/182, the motor being connected to the pinion shaft by Wellman Bibby flexible spring coupling. Two cast-steel flywheels, 6 ft. in dia., and each weighing approximately 2 tons, are carried on the pinion shaft.

The mill has proved to have a capacity of about 28 tons of hollow-drill steel bars per week, working a single shift, of 8½ hrs. In rolling hollow-drill steel, the first stand is used two-high, like the other four, that is to say, that only two rolls are mounted in each housing and, as the mill runs at constant speed in one direction, the bars are only rolled in one direction, being passed back over the top roll after each pass. The feature of the mill is the very gradual reduction of the billets, or, in other words, the very light drafting employed. The heaviest reduction, in the first stand, is ⅛ in. per pass, and this is later reduced to $\frac{1}{16}$ in. and finally to $\frac{1}{32}$ in. and less. The reduction of the 4-in. dia. billet to ⅞-in. hexagon section entails a total of some 55 passes through the rolls. The result of this gradual reduction is very thorough working of the steel, which, combined with a finishing temperature just below the critical point (700 deg. C.), produces a very fine structure in the finished bar.

ANOTHER FURNACE has been put in blast at the Gartsherrie works of Messrs. William Baird & Company, Limited, Coatbridge.

Commercial Moulding Sand Control for the Modern Iron Founder

DISCUSSION IN LONDON ON MR. F. HUDSON'S PAPER*

The BRANCH-PRESIDENT (Mr. C. H. Kain) commented that the Paper contained a great deal of information which would make the old school of foundrymen turn in their graves, and he was certain that very few present-day foundrymen were using 99 per cent. of old sand in their facing mixtures.

The HON. J. M. W. NORTH said he understood that 99 per cent. of the old moulding sand was used again, so that the new additions amounted to only 1 per cent. Considerably more than 1 per cent. of moulding sand must go out of the shop on the castings, however; this was made up from the old core sand, and he asked what percentage of old core sand was added to the shop sand to maintain the constant quality of old sand in the system.

Referring to the cooling drum, he said there did not appear to be a fan or other equivalent means of cooling the sand, and he wondered what was the length of time during which the sand remained in the drum, and at what temperature it came out.

The Silting-up Problem

MR. G. E. FRANCE said he had listened to the Paper with very mixed feelings. In the first place, he was intensely glad that at last we were getting to know something about sand control, the properties of sands and the manner in which they should be prepared; many foundrymen had been unable to complete the story by reason of lack of data, and it was pleasing to note that the need for proper research had at last been appreciated. But whilst he had been an advocate of reducing very considerably the quantity of new sand used in facing-sand mixtures, of the discontinuance of the use of facing sands as such, and the use of one moulding sand throughout the foundry, it was something of a shock to hear that for two months the author's foundry did not require any new sand. It was interesting to learn that at the end of the period of two months, under the conditions obtaining, the sand was not silting up; that experience was so unusual that Mr. France asked if the author had any confirmatory data from sources other than his own experiments. It was generally accepted that moulding sand did silt up, and he supposed the author would say that the silting up was due to the addition of the new sand itself.

The author's insistence upon the absolute necessity for magnetic separation was particularly pleasing. Although the cost of the installation was somewhat high, once the plant was installed the cost of magnetic separation was negligible—and it was a definite essential.

MR. G. C. PIERCE (Past Branch-President) asked what was the wood extract which the author added to the sand mixtures. He was not so alarmed as some people appeared to be with regard to the use of 99 per cent. of old sand. Surely those who were alarmed had lost sight of the fact that the whole of this sand was going through the plant and was being prepared. One would not like to see the moulders ramming up the whole of a mould with facing sand, and it was safe to say that about 10 per cent., or even less, of facing sand was all that was required in a mould. If one considered the figures carefully one would get somewhere near the author's figure of 99 per cent. But the problem of the silt had bothered him and he had wondered what became of it. In most foundries a proportion of the old sand was thrown away, but uses could be found for that sand, and some foundries did use it. But he was not prepared to accept that one could make much use of silt. He liked the idea of carrying on for two months without new sand, and did not wonder that feeling ran rather high; but at least that experience must nullify some of the prejudice.

Moisture Content and Mould Ramming

MR. W. TAIT said the author's reference to the flowability of the sand was particularly interesting, but he had not laid sufficient stress on the importance of moisture. It was stated that in America moulds were jolt rammed much more quickly than were moulds in this country; but it should also be pointed out that the moisture content of the American sand was very much lower than that of the sands referred to in the data sheets exhibited by Mr. Hudson. The sand used in one automobile foundry in this country had a moisture content of about 4 per cent., and it was said that the moulds were rammed much more quickly there than in most foundries in the country. The importance of the clay bond had also to be borne in mind. It was said that with a fireclay if one added four times the amount as compared with Bentonite the product was cheaper. One would have thought, however, that if an increased amount of clay were added it would be necessary to increase the moisture content, and that that would have affected the flowability of the sand. Further, one would imagine that the method of milling the sand would have to be changed. The author was passing the sand through a riddle; one assumed, therefore, that there were no lumps of new sand going into the sand mixer. It had been said that the effect of the mullers in the mill was to distribute the lumps; in large foundries in this country, however, where very large tonnages were used, good results were being obtained, although mullers were not used.

Finally, in a reference to the old pug mill referred to by the author, Mr. Tait asked if tests had been carried out to ascertain whether there was a breaking down of the sand grains in that mill.

Steel Castings Made in Silt

The BRANCH-PRESIDENT (Mr. C. H. Kain) was not quite sure whether or not the author treated the whole of his sand in the foundry; he had gathered that only a portion of it was treated, and that a considerable proportion went through the knock-out grid and passed straight back to the foundry.

Some really accurate information was required with regard to the silting up of the sand and the breaking down of the sand grains, and he would be glad if the author could give data on those matters. He personally had made steel castings in the silt taken from a dust-separating apparatus in his foundry, where considerable trouble was taken to separate the dust from the steel-foundry sand. He did not consider that the breaking of the sand grains in milling was at all serious. This matter had been raised very often in Papers dealing with oil sands, but in an ordinary mill, with a bed of sand about 1 in. thick under the rollers, it was not important, because the sand would flow.

Commenting on the author's reference to the strength of dried sand, the Branch-President asked what process was used for drying the sand specimens, what temperature was attained, and whether any moisture-exhausting apparatus was fitted to the oven. The estimation of the amount of gas evolved from the sand was most important; he asked, therefore, what apparatus was used for this purpose, how the gas evolution was measured, and whether the apparatus could be used with the other simple apparatus in the ordinary foundry.

AUTHOR'S REPLY

Sand-Cooling Methods

MR. HUDSON, replying to Mr. North, said the amount of sand lost was not great, and in Messrs. Glenfield & Kennedy's foundry 1 per cent. was the outside limit. The amount of sand in circulation was about 200 tons daily; 1 per cent. on that was 2 tons per day, and certainly not more than that amount was lost on the castings going into the dressing shop and from the waste sand being dumped. But he was not prepared to apply the figure of 1 per cent. generally; obviously, the loss would depend to a considerable extent upon the type of casting being made.

The cooling drums were not fitted with fans, but they had internal vanes which regulated the speed at which the sand came down the drums. The sand came down the drums in about 1 to 2 min., roughly, and the temperature of the sand leaving the drums was about 80 deg. Fah., *i.e.*, about blood heat. It then remained in the storage hoppers for about 2 hrs. before it was used, and during that time it cooled off to a temperature at which it could safely be used in the foundry. He had not been troubled in any way by hot sand; the plant produced cool sand without any particular precautions being taken. Here again, of course, the particular circumstances applying to individual foundries must be considered. In certain mass-production plants, where the same sand was being re-used more rapidly and more frequently, the sand would get hotter, and special provision would probably have to be made for cooling it. The production in Messrs. Glenfield & Kennedy's light foundry was roughly 40 tons of castings per day as a maximum, and about 200 tons of sand was in circulation. If, however, 100 tons of castings had to be made per day in 200 tons of sand, undoubtedly that sand would become too hot, unless equipment were installed to cool it.

Replying to Mr. France, he said that new sand additions were made only when the control tests indicated the need for such additions. At the end of the year 1933 he had totalled the number of months in which there had been no additions at all, and the number of months in that year when additions were not made was six. He drew Mr. Pierce's attention also to that point, and to the fact that the 1 per cent. addition covered a period of only six months in the year.

Silt in New Sand

With regard to silting-up, he had not obtained any confirmatory evidence other than that given in the Paper. Certainly when new sand was added the silt increased. Sieve tests, for example, showed definitely that since additions of new sand were stopped the percentage of fines or silt had been markedly reduced.

Wood extract was not very far removed from dirty water, as Mr. Pierce had suggested; it was a waste by-product of the paper industry, and the main sources of supply were Norway, Sweden, Newfoundland and Canada.

MR. V. C. FAULKNER (Past-President of the Institute) said he understood it was sulphite lyes.

MR. HUDSON agreed that it was. It had quite a strong dried bond, and was quite useful for the purpose he had indicated. Indeed, it could be used as a core oil, but its strength was not up to the usual standard for core oil.

Elimination of the Sand Bill

With regard to the control of facing sand, admittedly this sand was being used over and over again, as Mr. Pierce had indicated. But the whole point was that it was under control. In the old days the moulder took whatever facing sand he liked, and in many cases probably moulds were rammed up entirely of facing sand, or far more facing sand was used than was necessary. One great advantage of a system of control such as his was that the moulder could not use facing sand, and had to use what he was given. But the main advantage was the saving

*FOUNDRY TRADE JOURNAL, December 21, 1933, p. 351.

XUM

in sand costs. One was apt to be misled by the fact that the sand was used over and over again, and if he had used perhaps 98.5 instead of 99 per cent. of old sand the savings which had in fact been effected would probably not have been made. He was quite hopeful that in the very near future about 99.5 per cent. of old sand would be used in Messrs. Glenfield & Kennedy's plant; indeed, they were already using just about that percentage, because for six months of last year there were no new sand additions, and for the other six months 99 per cent. of black sand was used, so that the average for the year was about 99.5 per cent. The whole job had become very much easier for himself than it was at first. Certainly for two months the foundry foreman and the moulders were up in arms; for a time, every bad casting that was made was said to be bad by reason of bad sand, and some time had elapsed before he could convince them that it was not due to the sand at all. Then they began to take a greater interest in the matter, and more recently they did not worry very much about sand.

Commenting upon Mr. Tait's remarks, he emphasised that the sand he had described in the Paper was a natural sand, and a modification of a British sand. The sands of lower moisture content, such as those used in America and in some of the British foundries referred to, were definitely synthetic, and were usually made up from silica grains, re-bonded. They were of different type from that mentioned in the Paper and from that commonly used in this country. For the purposes of the Paper he had thought it wise to stick to the sands of this country, so that the bulk of the founders here could take advantage of the work with which he was connected.

Moisture Content and Scabbing

Admittedly, when the weaker clays were used one had to add larger quantities than was the case with the stronger clays, and the moisture content to obtain a suitable sand must be greater. But one could make of the moisture problem as big a bogey as that of the silt problem, and he was quite confident that the results obtained in Messrs. Glenfield & Kennedy's foundry, using sand containing from 6 to 7 per cent. of moisture, were as good as those obtained by the Americans and by some English automobile firms using sand containing between 4 and 4½ per cent. of moisture. One of the biggest problems on a hot summer day, even in Scotland, was the drying out of the sand, which could cause trouble. He was always averse to departing from his own practice because he felt that if the percentage of moisture were higher the sand did not dry out so readily as it did if the percentage were lower. Furthermore, the work on the expansion of sands had shown that in a green sand with a high moisture content the shrinkage arising from the removal of the water tended to balance the expansion of the sand grains, with the result that there was less scabbing. He was quite convinced that the ordinary theories put forward by the practical men as to the causes of scabbed castings did not meet the bill fully. Castings were sometimes scabbed when the sand was right and when the moulder had said that the ramming was right; there was something else we were trying to find out in order to get the whole story.

Insufficient Milling and Blown Castings

With regard to milling, Mr. Hudson pointed out that the mesh of the rotating screen was about ¼ in. The sand, when it left the screen, was not suitable for moulding, and it had to be milled. With all due respect to the paddle mixer, he still considered that it did not mix so efficiently as did a properly-designed mill, nor did it mix so quickly. At Messrs. Glenfield & Kennedy's foundry it was necessary to mix roughly 1 per cent. of new material in three minutes and to distribute the water uniformly, and he doubted that a paddle mixer would do the work in that time. Recently there had been a breakdown on one mill, so that it was out of action, as the result of inexperience; thus, the milling time had to be cut to about 1½ min., and there had been some trouble due to blown castings. It was found that the moisture was not properly distributed throughout the sand, some small patches containing 9 per cent. and others only about 3½ per cent. One could not distinguish them by the hand, but when the metal came into contact with a slightly wetter spot about the size of a shilling, a blow-hole was formed. One could not improve upon a properly-designed mill for efficient and rapid mixing. At the same time, if some simpler form of machine could be devised, it would be of advantage, because there was a good deal of wear on a mill. He made a point of fitting new scraper blades every week, and the scraper clearances were adjusted every morning, with a view to keeping the machines in good running order, but, even so, the wear was greater than one would desire.

Breaking Sand Grains in the Mill

At one time he had stated dogmatically that a mill did break down the sand grains, but he had since become less dogmatic about it, because, in the first place, a lot depended on the mill, and, secondly, it was a very moot point whether the grains did break down in a modern mill. The old mill he had described certainly would crush the sand grains, because in Scotland there was a habit of making loam from gravel. Coarse gravel river-bottom sand was crushed for about 40 minutes, and three or four shovels of ordinary boulder clay was added, and a beautiful loam was produced in that way. Very good castings, weighing up to about 50 tons, were made in it; it was most impermeable, like mud.

In reply to the Branch-President, Mr. Hudson said that all the sand at Messrs. Glenfield & Kennedy's foundry was treated. The dry-sand specimens were dried in an electric oven, having a natural-draft chimney to remove as far as possible all products from the drying. The temperature was controlled at 105 deg. C., and the drying was effected in about one hour. The oven was quite simple, and was made at the foundry from a couple of radiator elements, but it worked efficiently.

Finally, he said that in this Paper he had purposely refrained from any reference to the estimation of the gas evolved, because he had dealt with it previously. In a Paper on "Light Castings Production," which he had read in Scotland, he had described fully the two types of apparatus commonly used, and he referred the Branch-President to that Paper.

MR. W. T. GRIFFITHS, seconding the vote of thanks, said he was impressed with what Mr. Hudson had done that evening towards obtaining a greater "flowability" of information concerning sands. During the last ten years or more there had been a great deal of theoretical investigation of sand problems, and a whole mass of information had been collected as to what sands should or should not be; it was only by finding out what was happening in the foundries, however, that we should be able to use this valuable information. Mr. Hudson had indicated how he was applying that information by instituting proper control, and how it was even possible to make some profit out of sand control. Further, he was proving or disproving the various theories put forward, and when others followed the example of Messrs. Glenfield & Kennedy and installed accurate methods of control, the information obtained by theoretical investigations could be sifted and we should be in a better position to take advantage of it.

The vote of thanks to Mr. Hudson was accorded with acclamation.

What is Silt?

MR. J. W. GARDOM (Past Branch-President), proposing a vote of thanks to Mr. Hudson for his Paper, said he had wished that the questions of the fineness of sand and the moisture content had been dealt with more fully. Despite Mr. Hudson's final remarks, one felt that in future he would say that the most important thing was grain size. Further, it was essential, in order to ensure an even flow of sand in any mechanical system, to limit the water content and to increase the bond. The silt problem always worried foundrymen when putting in mechanical plant. The main problem was to determine what was silt. It was not necessarily fine sand; it might consist of small pieces of iron, and Mr. Hudson had definitely advocated the removal of this by magnetic separator. Again, Mr. Gardom suggested that Mr. Hudson was quite wrong in his references to the paddle mixer, and that if he had to mix 75 tons of sand per hour, the capital cost of the plant advocated in the Paper would be enormous. Finally, he suggested that most of the troubles experienced with sand used in the various types of ramming machines might be due to the percentage of air in the sand being wrong. Some foundries, he believed, had already found that they must definitely aerate the sand differently for the different types of machine.

AUTHOR'S REPLY

MR. HUDSON, responding, said the main difficulty so far was that there were far too few carrying on the work in the foundries. If more foundrymen and foundry executives would take up the practical study of sands we should arrive at some agreement with regard to details, such as those mentioned by Mr. Gardom, much more easily. The aim of Papers he had written was largely to interest the foundrymen in sand. If he succeeded in that he could deal more deeply with the science of sand testing; for the time being he had had to shelve these deeper studies because if he talked about them at this stage many people would not be able to appreciate what he was talking about. Moisture content and grain size were very important factors, and a considerable degree of agreement would be achieved in regard to these matters when there were a few more workers in the field. So far he did not believe there had been published in this country a Paper, dealing with sand, by a man who was directly in contact with the newer synthetic sands. His own experience of synthetic sands was more or less limited to what he had learned in America, and it would be of very great advantage to have a Paper on synthetic sands, so that foundrymen could compare notes and see how far agreement could be achieved. He suggested that on the Institute's Sand and Technical Sub-Committee there should be someone connected directly with that part of the industry.

When he had first suggested the use of less new sand in the foundry he was told that his ideas would not work. He had decided to take nothing for granted and to work only on the facts discovered, and as a result very much greater advance had been made than was made formerly. He had not attached much value to the old ideas of the foundrymen (which in many cases were rather "fancy") unless they were proved to be facts, and in the last year he had done more than during the nine years preceding it.

A Calendar and a Diary

Since acknowledging the various calendars and diaries which are a feature of Christmas post, we have received from August's, Limited, of Halifax, a monthly tear-off wall calendar of sizable dimensions, which is utilisable in the largest office for all but the most myopic of employees. It carries illustrations showing August's works and typical installations they have made. Unlike most calendars, it runs from February to February.

A diary was received from Universal System of Machine Moulding & Machinery, Limited, Wilson Street, London, E.C.2, and it is issued by Bonvillain & Ronceray, of Paris. The diary itself has four days to the page, but the really interesting part about it is the 100 odd pages of technical data. It is bound in imitation crocodile leather.

Foundry Progress

BOUQUETS FROM PROMINENT METALLURGISTS

Mr. J. R. Handforth's Paper* on "A Metallurgist's Outlook on Modern Foundry Production," presented to a meeting of the London Sections of the Institutes of Metals and British Foundrymen, threw into the limelight some of the more important recent developments. It focussed attention, as it was designed to do, on the need for co-operation by all concerned in the production of modern high-duty machinery.

The discussion was opened by MR. C. H. KAIN (President of the London Branch of the Institute of British Foundrymen), who, in expressing the appreciation of his members for the manner in which the London Section of the Institute of Metals had entertained them at the meeting, added that if the praise which Mr. Handforth had given to foundrymen was in itself the highest hospitality that could be offered and if foundrymen were greeted in the world to come as well as they had been greeted that evening, they would not have much to fear! As an iron and steel foundryman, he had been pleased that the author had alluded to the very vexed question of soundness, although he had left it to the end of the lecture. He could assure the author that in the iron and steel foundry there were also difficulties as regards soundness, and personally he regarded this as the major problem in the foundry to-day. The metallurgist supplied the foundryman with all the qualities in the way of strength that were required to meet the engineer's requirements, but the foundryman had to face the very difficult problem of making these alloys sound, and it was a problem which was not quite so easy as was sometimes suggested. The author had mentioned the Iron and Steel Institute Committee on Heterogeneity in Steel Ingots as showing the manner in which this problem was being tackled. The Iron and Steel Institute also had a Committee dealing with steel castings which had told rather a different story and had shown very clearly that the question of soundness was far from satisfactory, although a recent discussion in Sheffield indicated that the problem was well known and was being taken in hand.

Reference had been made by the author to the improvement that had taken place in cast iron during the past few years, and it had rather been suggested that this improvement had taken place entirely as the result of alloy additions. He could assure the author, however, that that was not so. The improvement in the quality of cast iron had been at least as great—he was referring to straight cast irons—as in the cast irons incorporating expensive alloys, and the common irons to-day—the straight silicon irons—were giving results at least 100 per cent. better than was the case 10 years ago. This had been largely due to the invasion of the foundry by the metallurgist and the control of melting conditions.

What is "Readily Machinable"?

As one who, for his sins, had to make grey-iron castings, he was very pleased the author did not say that these castings were readily machinable, because it was rather a vexed point with foundrymen. Metallurgical Papers were frequently published in which results were given of remarkable cast irons of 30 tons tensile and with a Brinell hardness of the order of 250 to 350, which were described as being readily machinable. To the ordinary engineer who had some good boring mills and lathes, such materials were machinable, but the modern production engineer interpreted the term "readily machinable" in terms of cutting at speeds of 250 or 300 ft. per minute. With such materials as he had referred to these speeds could not be attained. For that reason, whenever he saw a Paper on this subject, he always tackled the author as to what he meant when he said the material was "readily machinable," as many had suffered rather bitterly in that connection recently.

The Worth of Heat-Resisting Cast Irons

MR. J. F. KAYSER said the Paper was quite misleading, and it had even misled the chairman, who seemed to be under the impression that all the things spoken of in the Paper had been developed during the last five years. Cast irons were known 100 years ago, and as regards heat-resisting cast irons the author, like many others who had read Papers recently, had compared heat-resisting irons with nickel-chrome heat-resisting iron. One might just as well compare the free ferry at Woolwich with the "Mauretania"! Heat-resisting alloys were developed over 20 years ago by Marsh, who discovered—and it was well known in Sheffield—that it was possible to produce heat-resisting alloys with a high carbon content and somewhat similar to the present heat-resisting cast irons, but they were not made because it was realised that they were exceedingly low-grade heat-resisting alloys. These alloys were not an improvement on cast iron; they were merely spoiled heat-resisting alloys such as were first produced in considerable quantities in America just before the war and which were started to be produced in Austria during the war. They were not economic, however, and were merely suitable for manufacture by foundrymen who had not the pluck to make a really expensive alloy and sell it. That was the whole truth about that matter.

MR. A. H. MUNDEY said it was a little regrettable that the last speaker should have been so discouraging, because personally he felt the greatest possible debt of gratitude was owing to the author for having drawn attention to such a tremendous amount of most interesting work, both to works metallurgists and foundrymen. It was natural that in such a general Paper special work should have received comparatively scant attention, and it obviously had not been possible to go into a great deal of detail in special cases, as the ground to be covered was obviously much too large. From the non-ferrous point of view, however, he could speak with some authority, the facts and figures given in the Paper were most interesting and were up to date.

MR. HUTCHINSON, speaking as a production engineer, expressed his appreciation of the strides that had been made, and which had been indicated in the Paper. It was impossible to have reliability in the finished product if the reliability of the materials used could not be counted upon. The Paper, however, had clearly indicated that the foundry—dare he say it!—was at last really making efforts to keep up with the progress made by the other branches to which he had referred.

Progress in Silicon-Aluminium Alloys

MR. R. B. DEELEY said that he was sorry to hear such frequent reference to the speckiness of aluminium alloys, but he would like to emphasise that the author had indicated that considerable progress had been made during the course of the last few years.

With regard to the popularity of the 5 per cent. silicon alloy in the United States, he suggested that its ease of casting and fluidity were a characteristic of the aluminium-silicon alloys generally and was due to the fact that they were of so nearly eutectic composition. He believed that the popularity of the 5 per cent. alloy as compared with the 12 per cent. alloy more commonly used in this country had been due to the fact that there had been some difficulty in satisfactorily carrying out modification of the higher silicon alloys in America, and difficulties had been encountered there in keeping the iron content down to the limit which was felt necessary on this side of the world.

With regard to the hot-shortness test mentioned by the author, he (Mr. Deeley) had been very interested in this type of test since its instigation and felt it would have been of interest had the author stated the maximum length to which the alloy R.R. 50 could be cast without cracking, since in silicon alloy to Specification D.T.D. 25 it had been possible to cast up to 8 or 9 ft. with no clearance without any sign of hot-shortness, and he imagined that it would be possible with this latter alloy to go almost to unlimited lengths on account of the eutectic composition, which property no other commonly-used aluminium alloy, so far as he was aware, possessed.

The new series of aluminium-silicon alloys which the author had referred to was one of the most modern improvements in aluminium-silicon alloys, in that they possessed the virtues of freedom from hot-shortness and yet had the fluidity of the ordinary eutectic aluminium-silicon alloys, and at the same time had very much enhanced mechanical properties, particularly proof stress.

Beryllium-Copper, Manganese and Aluminium Bronzes

MR. MURPHY said the Paper was of the high standard that was to be expected from the author's own work as the representative of an industry which always demanded the highest from the materials with which it was supplied. There was little doubt that the aircraft industry during the past five years had been responsible for a tremendous impetus in scientific metallurgy. With the author, he himself had been very interested in the development of the beryllium-copper alloys. For a few years we only heard of the results obtained from forged materials, and they promised to be epoch-making, especially when the economic conditions improved. As regards sand castings, however, the results had been disappointing in comparison with those obtained with the forged material. He believed the latest results for beryllium-copper had been given by the author. The tensile strength with the double heat-treatment was a little more than 50 tons per sq. in., with an elongation of only 1 per cent., but it ought to be known that with manganese-bronze cast in sand, without any heat-treatment, it was possible to obtain a tensile strength of 50 tons per sq. in., with an elongation of 15 to 20 per cent. There was the difference that the beryllium-copper alloy had a much higher hardness, and where that particular property was important there was the possibility of the beryllium-copper alloy justifying itself. Where tensile strength was the desired property, however, that could be obtained now from manganese-bronze without any heat-treatment. The demands of aero-engine design and similar very high-quality work often led one into curious, but important, paths, and one in which he had been interested recently related to the fatigue strength of bronzes. In that connection it would be interesting to know if the author had considered the possible wider application of aluminium-bronzes, which were remarkable for their very high fatigue strength. Comparing an aluminium-bronze and a manganese-bronze having the same tensile strength, it would be found that in the cast condition the aluminium-bronze had a fatigue strength of 50 per cent. greater than that of the manganese-bronze.

Vote of Thanks

The CHAIRMAN (Dr. C. J. Smithells), proposing a hearty vote of thanks to the author for his Paper, said it was clear that its preparation had meant a considerable amount of work. The

* FOUNDRY TRADE JOURNAL, January 4, 1934.

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development of these new alloys had depended on the addition of relatively small quantities of materials, and this was of particular interest to him because about six years ago he had tried to write a book dealing more or less with the effect of the addition of small quantities of materials in that way. Fortunately, however, that was six years ago, because if he had had to do the same now it would have been utterly impossible to review all the available material. There were one or two things in the Paper which particularly struck him as noteworthy. For instance, there were the extraordinary magnesium alloys with a tensile strength of 17 tons, remarkable when one thought of magnesium ribbon which broke when it was bent. The other point was the effect of pouring sulphur into the mould before the metal was cast. He was looking at Mr. Griffiths in this connection with the thought of sulphur in nickel, and although sulphur seemed to be the one element which was invariably harmful, yet it seemed to have been the salvation of magnesium.

MR. G. C. PIERCE, who seconded the vote of thanks, said that he had come to the meeting that evening rather moody on account of the nasty weather and more particularly because the author had quite recently rejected some work of his! It was clear from the Paper that the author had shown the same care in examining that particular piece of work as he had done in preparing the Paper. At any rate, he himself had taken a very long time to see just exactly where the fault was which had caused the author to reject the work in question. However, he had eventually found the trouble with a glass! Nevertheless, he had thoroughly enjoyed every moment that had been taken up by the author in presenting his Paper and was not so much concerned as to whether some of these things were known "donkey's years ago" or not. Everybody must agree that it would have been very difficult to have improved upon the manner of the presentation of the Paper and upon its contents. Looking at the specimens which the author had exhibited, the point was brought home to him very forcibly that although it might be an easy task to the author to talk about these castings, it was a little different matter actually to produce them.

The vote of thanks was carried with hearty acclamation.

AUTHOR'S REPLY

MR. J. R. HANDFORTH, replying to the discussion and acknowledging the vote of thanks, said the Paper had certainly taken a long time to prepare, but that the reception he had been given had made it well worth the while. Moreover, in the preparation of the Paper he had learned a great deal. In the first place, he wished to take this opportunity of thanking the various firms who had so very kindly loaned him lantern slides and castings for exhibit, namely, the English Steel Corporation, Messrs. Thos. Firth & John Brown Limited, Messrs. Hadfields, Limited, Stokes Centrifugal Castings Company, Limited, the Mond Nickel Company, Limited, the de Havilland Company, Limited, High Duty Alloys, Limited, Sterling Metals, Limited, and British Maxium, Limited.

As to the discussion, continued the author, he did not intend to say much by way of reply. Taking the speakers in their reverse order, he thanked Mr. Pierce for his kind remarks, and agreed with Mr. Murphy that beryllium-copper alloys were something of a disappointment. He understood, however, that new alloys were being tried of beryllium and nickel, but the most important point about beryllium was its present price, which was almost equal to that of gold, and until it became a more commercial price he did not see how it could possibly be used. He had no experience of the other point mentioned by Mr. Murphy—the fatigue values of aluminium bronzes.

As to silicon alloys, Mr. Deeley was an expert on that important branch of aluminium founding and what Mr. Deeley said must be accepted in preference to anything which might have been said in the Paper. Personally, he had had no experience of the latest modifications of the 13 per cent. silicon alloys containing manganese and magnesium, and he had been careful to explain that position in the Paper. He was pleased to learn from Mr. Deeley that the teething troubles of the new alloy had now been overcome, and he wished him every success with this new and important alloy.

MR. DEELEY: I merely wanted to reassure you.

MR. HANDFORTH, continuing, thanked Mr. Hutchinson for his contribution to the discussion, and apologised for not having mentioned the part played by the production engineer in improving foundry products.

He thanked Mr. Mundey for his kind defence against the attack of Mr. Kayser, and stated that Mr. Kayser's contributions to technical discussions, both written and oral, were neither pleasing nor helpful.

In connection with Mr. Kain's remarks on the meaning of machinability, Mr. Handforth said the meeting might be interested to hear his own introduction to that problem. His first experience of the control of foundry work was under the guidance of the late Mr. E. H. Broughall, the works manager of Messrs. Alfred Herbert & Company, of Coventry. Mr. Broughall first explained to him that various types of cast iron were made, some of which must be soft for easy machining and some of which, particularly lathe bed metal, must be hard to ensure good wearing. Mr. Broughall explained that it was possible to see what type of bed metal was being supplied as one walked through the shops. A lathe bed leaned up against a wall marked H, for hard, need not be worried about. If half-a-dozen lathe beds marked XH, for extra hard, were seen against the wall, even that need cause no anxiety. When, however, one saw a series of lathe beds marked XBH, it was then time to take a second look at one's mixtures to ensure that the machine shops were not getting into really serious difficulties.

Wear Resistance of Cylinder Cast Irons

By measuring the increase in diameter of worn-out internal-combustion-engine cylinders, A. Wallichs and J. Gregor have found that the wear of the bore is primarily caused by the sliding action of the piston rings, the radial pressure of which is increased by the gas pressure.* Accordingly, in the experiments on the resistance to wear of a variety of cylinder cast irons which have been carried out by the same authors, a test method was chosen in which the test piece cut from a cast plate of cylinder wall thickness was pressed under a definite pressure against a rotating piston ring sliding in an oil bath. Further tests were made on the same irons using a testing machine, in which the specimen was pressed against the surface of a rotating pearlitic cast iron disc. These tests were made without lubrication. Finally, two of the irons were tested in the form of cylinder blocks and piston rings in two automobile engines.

The results of the two experimental series carried out with the two abrasion wear-testing machines, though they differed from each other in the absolute value of the wear as determined by the loss in weight, yet allowed the irons tested to be arranged in the same sequence with regard to their wear resisting qualities. From the test results the following conclusions can be drawn. Of the common elements carbon, silicon, manganese, and phosphorus, only the graphite content gives some indication of the wear resisting quality of the iron, as far as irons containing less than 1.9 per cent. proved very resistant to wear. Nickel in amounts of less than 2 per cent. gave a slight increase in wear resistance when the wall-thickness remained constant. Nickel plus chromium in amounts of less than 3 per cent. increased the wear resistance of thin sections, and decreased the resistance of thicker sections. In amounts of more than 3 per cent. nickel plus chromium gave an average increase in wear resistance of 25 per cent. In all cases, the alloy additions increased the hardness.

The hardness alone is not a reliable measure of the wear resistance, the structure must also be taken into account. This was shown by the fact that, with one exception, all the irons tested had a 1.5 to 3 times higher resistance to wear when cast in thick sections (27 to 30 mm.) than when cast in thinner sections (9 mm.). The effect of the structure could, at least partly, be determined quantitatively by measuring, under the microscope, the linear graphite interspersion, that is, the number of graphite flakes which were intersected by a straight line 1 mm. in length. In the following table there are recorded the results of three of the irons tested under equal conditions, which show the great influence upon the wear of the form and distribution of the graphite. The least desirable size of the graphite is the finely divided form which, generally, is found in the ordinary irons with small, if any, alloy additions.

As to the effect of the metallic groundmass it was found that a coarse pearlitic structure such as is obtained in irons treated according to the Lanz Perlit process has a very high resistance to wear. The two Lanz irons tested gave better results than a high-alloy cylinder iron (4.85 per cent. Ni + 1.51 per cent. Cr), to which a special heat-treatment had been applied. This iron showed a fine martensitic structure. The best result was obtained with an iron containing a nickel 2.95 and chromium 0.04 per cent., which was treated according to a special process similar to the Lanz process. The sorbitic structure of this iron contained some pearlite and was interspersed with long thin cementite needles. It is to this acicular cementite that the excellent resistance to wear must be attributed. The good behaviour of the unalloyed Lanz irons is of special interest since alloy additions always impair the machinability due to the increase in hardness.

Iron.	Chemical Composition.								Wear loss in weight. Mg.	Linear graphite interspersion.	Rockwell B-hardness.
No.	T.C.	Gr.	Si.	Mn.	P.	S.	Ni.	Cr.			
41*	3.2	2.4	0.89	0.42	0.16	0.12	0.59	0.08	12	7.3	98.2
32	3.37	2.64	1.69	0.74	0.29	0.10	0.20	0.03	35.7	13.6	98.6
22	3.25	2.58	2.13	0.81	0.29	0.09	0.40	0.11	13	25.7	98.0

* Lanz Perlit iron.

"Die Giesserei," 1933, Nos. 47-48, 49/50.

Research in Industry

Presiding at the annual luncheon recently of the British Electrical and Allied Industries Research Association, Sir Hugo Hirst stressed the value of research in industry. In the electrical industry, he said, they saw a gradual improvement month by month. Sooner or later saturation point would be reached in the home industry. What was wanted was more export business. With the nationalist tendencies of each country to exclude imports, there was but one chance for us to increase our exports, and that was by research and invention. No country had a better record for invention and application than this country.

Alloyed Cast Iron

MR. J. E. HURST presented his Paper on "The Addition of Non-Ferrous Metals to Cast Iron" to a joint meeting of the Newcastle Branches of the Institute of Metals and the Institute of British Foundrymen. It was printed in our issues of January 11 and 25, 1934.

MR. NEWSON, chairman of the local section of the Institute, presided, and opened the discussion. He said they would all agree with him that they had listened to a very fluent and lucid account of a most interesting subject. He would like to ask Mr. Hurst to what limit the effect of manganese alone had been pursued, as it had remarkable properties when added to steel in the proportion of 12 to 14 per cent. He wondered whether it would be advantageous when added to cast iron in slightly greater quantities than normally found. The addition of copper instead of nickel to cast iron, on account of cheapness, was a new thing to him, as he had understood that its effect on the structure was very slight.

Breaking Down Boundaries

MR. HURST, speaking with regard to the question as to whether the subject of his lecture was within the scope of the Institute of Metals, said he felt that the development of alloy materials, both in steel and iron, would go a long way towards breaking down the boundary between ferrous and non-ferrous materials which had been so clearly defined in the past. Whether it was going to be an advantage in the long run he could not say. Turning to his question as to the effect of manganese, that had been gone into, and he believed that many metallurgists looked with very envious eyes on the possibility of making austenitic cast iron with manganese because it was so much cheaper than nickel. It had a very powerful effect in bringing about the austenitic condition. No-mag type of austenitic cast iron took advantage of the use of manganese, and he thought that it was common knowledge that the study of the effect of manganese was being pursued by various people. He believed that there were one or two austenitic cast irons manufactured to a limited extent which depended more or less on the use of manganese. The question of cost was itself very vast, but he would remind Mr. Newson that it was possible to make austenitic cast irons with nickel at prices which compared favourably with non-ferrous materials.

Electrical Properties of Cast Iron

MR. S. E. DAWSON said that he agreed with Mr. Hurst that it was difficult nowadays to know where non-ferrous and ferrous work began and ended. With regard to Mr. Newson's question about the addition of manganese, he thought Mr. Hurst would agree that the objection to its addition was the formation of manganese carbides, which gave hardness and made the castings unmachinable. No-mag iron was really based on the effect of manganese on the production of austenitic iron. Mr. Hurst had not brought forward the reason for that. Nickel, of course, was another element which had the same effect, except that it was only half as strong. Hence the value of trying to use manganese for that purpose was that it was not only cheaper, but stronger. They had all been tried out with steel, and recently an alloy had been patented which contained manganese, nickel and chromium in varying proportions, depending on the requirements of the alloy. He did not think that Mr. Hurst had quite stressed the very useful property in austenitic irons of electrical resistance. The electrical resistivity of austenitic cast irons was 140, which was higher than anything else which had ever been discovered. He did not think enough use was made of austenitic cast iron for electrical machinery. For short-time service, where little heat was produced, austenitic cast iron would provide the right material.

With reference to the high-strength effect of nickel, they had seen some wonderful tensile results on the screen, and he could assure them that they were quite correct. They knew that in austenitic cast irons, for example, the effect of nickel had not done anything to strengthen the metal. High strength could not be obtained in austenitic cast irons. It was dependent on the original structure of the iron. As to copper replacing nickel, that again was part of his original patent, but only when machinability could be sacrificed. A definite result of the addition of copper was increased hardness. Mr. Hurst had shown the softening effect of copper, but he was sure that that was only in conjunction with chromium cast iron, when the copper removed the effect of the chromium. In conclusion, he would like to thank the lecturer very much for his most interesting and informative lecture.

A New Field Opened

MR. HURST said that he was very glad indeed that Mr. Dawson had been able to speak, for, as he had indicated at the outset, Mr. Dawson was responsible for the early introduction of austenitic cast iron. Consequently he spoke with very great authority. He had recited a number of what might be sins of omission on his part in dealing with the properties of austenitic cast iron and he was quite aware of the fact, as he could only deal superficially with the whole question in one lecture. What Mr. Dawson had said of its extraordinary properties of resistivity was perfectly correct and was a most valuable addition to the qualities of those materials. It was true that only the fringe of the subject had been touched. Prof. Andrew, lecturing in Sheffield the previous evening on the subject of alloy steels, had made the same remark in connection with them, and such alloy steels had, of course, been prominent for many years now. On the subject of high-strength cast irons he had deliberately not used the word "inoculated" because he did not care for it, but he had tried to stress the fact that those high-strength cast irons were only made by the subsequent addition of nickel and silicon to an iron initially white. On the subject of copper, he thought that on the whole copper additions had a slight hardening effect. It was slight, however, and the softening effect shown in the slide was, as Mr. Dawson imagined, due to the effect of copper in conjunction with chromium. He did think, however, that the main outstanding effect of copper additions had not been generally realised. It had a most remarkable effect in refining the grain size. After making a copper addition to cast iron it brought about a very marked closening of the grain, particularly in the thin sections. As he had already indicated, copper had a very limited solubility in cast iron. It was a fact that even with less than 3 per cent. it was very difficult to be sure that the copper was thoroughly dissolved. Often if microphotographs were taken of cast iron which had had copper added, globules of copper could be seen in the metal.

Are Small Alloy Additions Worth While?

MR. C. VAN DER BEN said Mr. Hurst had dealt with an extremely wide field; the subject of alloy additions to cast iron nowadays was a vast and very interesting one. He thought it could be broadly divided into two groups, firstly, where the additions were comparatively small and the material was still essentially cast iron, and secondly, where sufficient alloy had been added totally to change the nature of the material.

With regard to the subject of comparatively small additions, of nickel and chromium in particular, he wondered if Mr. Hurst would agree with him in saying that in many cases similar results could be achieved by the adjustment of the elements usually present. Mr. Hurst had shown a slide giving various analyses where there was a small proportion of chromium present. In one particular case, for example, that of a Diesel cylinder containing 0.4 per cent. of chromium and 1.5 to 1.6 per cent. silicon: had the silicon been reduced by about ½ per cent. and the chromium omitted would not a similar effect have been obtained?

With reference to high additions of chromium to cast iron, these alloys, whilst they had excellent heat- and scale-resisting qualities, were extremely brittle, which was a great disadvantage.

He was interested in the slide showing the increase of Brinell hardness after heat-treatment; one point which had struck him was the low initial Brinell hardness, and he would be glad to know the composition of the material.

MR. HURST said that Mr. Van der Ben's remarks resolved themselves into two points—whether or not small additions of alloys were really worth while and with particular reference to small additions of chromium in engine-cylinder castings. He did not think he could agree with the speaker that the same effect could be obtained quite so satisfactorily in the case he supposed by the reduction of the silicon; there again they must rely on facts. In the first place, if the silicon content in that particular composition had been reduced it would have been extremely difficult to make the casting. With regard to the effect of small additions of chromium on the behaviour of cylinders, this had been explored experimentally; it was an experimental fact that it had been found that there was a definite improvement in cylinder life with chromium-iron blocks. That being the case, he could not altogether agree. There were applications where small percentages of chromium were a definite commercial and economic advantage. That, of course, applied to the other alloy cast irons. He did not want them to go away with the impression that these alloys were the cure of all the ills cast iron was heir to.

A vote of thanks was proposed to Mr. Hurst by the CHAIRMAN (MR. NEWSON) and seconded by MR. DAWSON. MR. HURST briefly replied.

Induction Melting Furnaces

(*Concluded from page* 132.)

metallic template heated by induction frits a dry refractory to a certain depth, or by ramming a plastic refractory around wood formers, subsequently filling the space left between the rammed portion and the coil with a dry refractory. In another method the dry powder is rammed lightly between a crucible of asbestos lumber and the coil, and the lining is fritted by the first charge which melts the asbestos former. In a further method "green" tongued and grooved bricks are used, with a backing of loose refractory. This method is only suitable where the bricks can be made "on site," as they are rather fragile for transporting.

Acid linings generally consist of crushed and graded quartzite with a boric-acid bond. These give exceptionally good service, and if the grading and quality of materials are satisfactory, 60 to 70 heats can be obtained with small furnaces (3 to 10 cwts.), and up to 200 heats for larger furnaces. Magnesite, magnesite-alumina, and magnesite-zircon are in use for basic linings, but there still remains much research in this direction. Some linings of crushed magnesite mixed with basic slag as a bond have given 50 to 60 heats, but the average is lower than this.

The possibilities of this type of furnace as a medium for ensuring a positive degree of deoxidation and clarification from inclusions have been indicated, and by the use of duplex process many of the higher-priced steels could be improved and produced economically. The field for the furnace as a refining appliance still remains to be determined, but large-scale experiments are being undertaken in furnaces up to 5 tons in capacity. An improvement in the reliability of basic linings will undoubtedly be required before this is a complete success.

XUM

This Week's News in Brief

Trade Talk

A LARGE NUMBER of the members of the Glasgow University Engineering Society visited the works of the Singer Manufacturing Company, Limited, Clydebank, on February 17.

MESSRS. R. & A. MAIN, LIMITED, Gothic Iron Works, Camelon, Falkirk, are again extending their enamelling shop to 115 ft. by 112 ft., at an estimated cost of £2,000. Plans have been passed by Falkirk Dean of Guild Court.

THE DIRECTORS of Messrs. Mather & Platt, Limited, Manchester, are convening an extraordinary meeting at which a resolution will be submitted for the conversion of the £10 preference shares and £1 ordinary shares into stock, transferable in units of £1 each.

MESSRS. WILLIAM DIXON & COMPANY, LIMITED, have addressed an inquiry to the Glasgow Corporation with a view of ascertaining if they would be willing to entertain an offer by them to supply coke-oven gas from a new plant which it is proposed to install at Govan Iron Works.

THE CUSTODIER at Glasgow police headquarters was surprised to receive this week from a lorry driver four steel shafts, 24 ft. by 1¾ in., which he had found lying on the Glasgow-Carlisle road at Hamilton. Five similar shafts have been found on the road in Dumfriesshire.

THE FREE TRADE WHARF COMPANY, LIMITED, have placed an order with Messrs. R. & W. Hawthorn Leslie & Company, Limited, Hebburn-on-Tyne, for a coasting steamer of 1,000 tons deadweight. The machinery will be made by the North-Eastern Marine Engineering Company, Limited, Wallsend.

THE ANNUAL DINNER of the British Electrical and Allied Manufacturers' Association has been arranged for Thursday, May 17, and will be held at the Connaught Rooms, Great Queen Street, London, W.C. The President of the Association, the Rt. Hon. the Earl of Derby, K.G., will preside.

MR. CHARLES MITCHELL addressed the iron and steel sub-committee of the Conservative Private Members' Trade and Industry Committee at the House of Commons recently. Mr. Mitchell, who is the chairman of the National Committee of the industry, spoke on the proposed reorganisation plans.

THE STAFF of the Motherwell Bridge & Engineering Company, Limited, and their friends spent a happy night at the firm's annual whist drive and dance in the Salon, Hamilton, recently. The function proved most enjoyable, and during the evening the company sent a cable of good wishes to Mr. T. R. Miller, the managing director, who is travelling in Palestine on a combined business and pleasure trip.

THE FIRST 500 TONS of pipe line for the new Jerusalem water supply have arrived in Palestine and been distributed along the route between Ramleh and Ludd. It is understood that the pipes will be laid along the main road to Jerusalem and will avoid the foothills. Springs at Ras-el-Ain, 60 miles from Jerusalem, are to supply the capital with water. There will be four pumping stations, with a reservoir at each station.

MESSRS. HARLAND & WOLFF, LIMITED, have secured an order to build four vessels for the Union Castle Line, two passenger motorships similar to the "Warwick Castle," which is over 20,000 tons, and two medium-sized motor cargo vessels. The former will be built at Belfast, but it is probable that the latter will be built at the Govan yard. Messrs. Harland & Wolff, the busiest shipbuilding firm in the world, have now 17 vessels on order.

MESSRS. P. HENDERSON & COMPANY, LIMITED, Glasgow, managing owners of the Henderson Line, have placed orders for two cargo boats with Messrs. D. & W. Henderson, Limited, Partick. The vessels will each be of 8,000 tons carrying capacity, specially designed for Messrs. Henderson's Eastern trade. One of the vessels will be fitted with the Stephen three-cylinder compound steam engine, the new design evolved by Messrs. Alex. Stephen & Sons, Limited, Linthouse.

THE ALBION MOTORS, LIMITED, Glasgow, have received warrant of appointment as motor-lorry manufacturers to H.M. the King, and to mark the event a party of civic representatives, including the Lord Provost, were shown round the works. The Albion Motors, Limited, have supplied motor-lorries for use on the King's estate at Balmoral. The first vehicle was delivered four years ago, and since then there have been two repeat orders. Mr. N. O. Fulton, chairman of the company, informed the party that the works were started in 1899, and he said there were now between 1,600 and 1,700 people employed at Scotstoun.

MESSRS. BARCLAY, CURLE & COMPANY, LIMITED, Whiteinch, have secured a contract to build for the Leith, Hull & Hamburg Steam Packet Company, Limited, a steamer for their Continental and Mediterranean trade. The ship will be 260 ft. long by 40 ft. beam and 26 ft. deep, of the shelter-deck type, fitted with triple-expansion reciprocating engines of the latest design. Messrs. Barclay, Curle & Company have also contracted to build the engines for a sister ship, which is to be constructed by the Caledon Shipbuilding & Engineering Company, Limited, Dundee. The boilers for this ship will be constructed by the Caledon Company, who will also install the machinery at Dundee.

FURTHER EVIDENCE of increasing activity in the heavy industries in Scotland is provided by the decision of the Shotts Iron Company, Limited, to put another of their furnaces into operation. At present they have two furnaces in blast, and a third is now being relighted in view of the growing demand for Scotch pig-iron. The furnace being rekindled is one of the largest and most modern at the works. The restart of this furnace along with the one recently blown in at Gartsherrie will bring the number of pig-iron furnaces in blast in Scotland to 12, the largest number since the beginning of 1930, when there were 24 in operation. As recently as July, 1933, there were only three furnaces operating in Scotland.

THE EXECUTIVE COMMITTEE of the West of Scotland Engineering and Shipbuilding Organising Council met this week in Glasgow to consider the replies received from the Clyde District Committees of the shipyard trades unions to the following resolution: "That this meeting of representatives of the trades in the engineering and shipbuilding industries herewith decide to stop all overtime as from February 28 and that a vote of the unions be taken on this question for stopping overtime." As some of the unions had not completed returns, it was agreed to postpone the date of the ban on overtime and to ask the unions to send in completed returns by March 10, in order to give all unions time to ascertain their members' views. It is contended that the ban on overtime is justified by the large numbers of all classes of shipyard workers who are unemployed.

A NEW AND IMPORTANT INDUSTRY is being built up in Inverness by the Rose Street Foundry & Engineering Company, Limited, in the making of electric welding machines for various purposes. Some years ago the management renewed the patent rights of a resistance welding machine. The machines made in Inverness have the distinction of producing the largest number of motor-car rims and bicycle rims in this country. The machines have been sent to Soviet Russia, France, Italy, Austria, Sweden, Japan, the Argentine, Canada, Norway, Ireland and Denmark, in some cases replacing the German machines, which had been found unsuitable. The system has been approved by the Marine Department of the Board of Trade, by Lloyd's Register, and by the British Corporation for the welding of steel flanges to steel plates for main steam pipes on passenger and other vehicles.

Company Reports

Clarke, Chapman & Company, Limited.—Directors are unable to recommend any dividend on the ordinary shares for the year to December 31, 1933.

Mather & Platt, Limited.—Dividend on the ordinary shares at the rate of 3½ per cent. for the half-year ended December 31, 1933, making 6 per cent. for the year.

Ewart & Son, Limited.—Net profit, £35,418; brought in, £9,043; preference dividend, £16,112; ordinary dividend of 20 per cent., £15,874; carried forward, £12,475.

Metropolitan Electric Cable & Construction Company, Limited.—Net profit, £15,580; brought in, £799; to reserve for taxation, £4,000; final dividend of 5 per cent., tax free, making 10 per cent.; to capital reserve, £5,685; carried forward, £694.

Personal

MR. AND MRS. WILLIAM TOWERS, of Stark Avenue, Camelon, Falkirk, celebrated their diamond wedding on February 13. Mr. Towers, who was born in Carronshore 81 years ago, is a moulder.

MR. HAROLD MACMILLAN, M.P., has accepted the office of President of the Institute of Industrial Administration for 1934. Mr. Macmillan is a director of the Great Western Railway.

Wills

WOODHEAD, W. H., of Leeds, retired axle and spring manufacturer	£137,222
WRIGHT, J. C., of Stirling, manager of the Burnbank Foundry Company, Limited	£6,655
TONKS, DANIEL, chairman of Messrs. James McDougall, Limited, Hope Tube Works, Wednesbury	£2,609
GOLDSCHMIDT, E. C., partner in Messrs. Brandeis, Goldschmidt & Company, metal merchants, of London	£85,944

Contracts Open

Plymouth, February 27.—5,000 yds. of 9-in., 6-in., and 4-in. cast-iron or spun pipes, for the Town Council. The Water Engineer, Stonehouse Town Hall, Plymouth.

India, March 1.—Rings, piston, valves, floating type, for the North Western Railway, Lahore. The Department of Overseas Trade. (Reference G. 13,434.)

Skipton, February 24.—One weighbridge, 20 ft. by 8 ft., for the Urban District Council. Mr. N. B. Thompson, engineer and manager, Gasworks, Skipton.

Obituary

SIR VINCENT RAVEN, President of the Institution of Mechanical Engineers in 1925 and formerly technical adviser to the London & North Eastern Railway Company, died at Felixstowe recently at the age of 75.

SHORTLY AFTER THE RESUMPTION of work following the mid-day interval, Mr. Rennie Fleming, foreman in Messrs. Smith & Wellstood's Columbian Stove Works, was seized by a sudden illness, and died almost at once.

THE DEATH OCCURRED very suddenly on February 11, at his residence in Bearsden, near Glasgow, of Mr. David Carlaw, a director of Messrs. David Carlaw & Sons, Limited, mechanical and automobile engineers, Finnieston, Glasgow. Mr. Carlaw, who was a son of the founder of the firm, was a native of Glasgow, and had been associated with the firm throughout his business career, being identified particularly with the mechanical engineering side. He was 68 years of age.

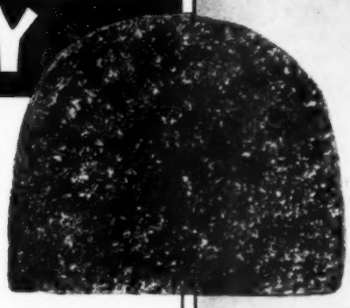
AS BRIEFLY ANNOUNCED in this column last week, Mr. Alfred Lucas died at his home, 110, Brincliffe Edge Road, Sheffield, recently, in his 70th year. He was a well-known figure in the engineering world in the North of England. For 33½ years he was manager of the Sheffield district office of the British Thomson-Houston Company, Limited, from which position he retired a year ago. Although born in Sheffield, Mr. Lucas received his early training at Barnsley, where he commenced his career with a firm of ironmongers. Later he returned to Sheffield and entered the service of Tasker, Sons & Company, electrical engineers, where he remained 14 years. When the Sheffield Electric Light & Power Company was taken over by the Corporation in 1897, Mr. Lucas went with it as superintendent of mains under the Electric Lighting Committee. A year and a-half later, early in 1899, he became Sheffield district manager for the B.T.H. Company. He was, in fact, their first Sheffield representative, and they were the first electrical engineering firm to open offices in Sheffield.

AN ARRANGEMENT has been entered into between G.W.B. Electric Furnaces, Limited (proprietors, Gibbons Bros., Limited, and Wild-Barfield Electric Furnaces, Limited), and Shell-Mex & B.P., Limited, whereby new high-grade quenching oils will be placed on the market. They will be known as Shell-Wild-Barfield quenching oils.

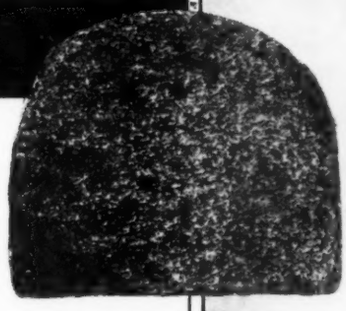
K.H. PIG IRON

BRAND

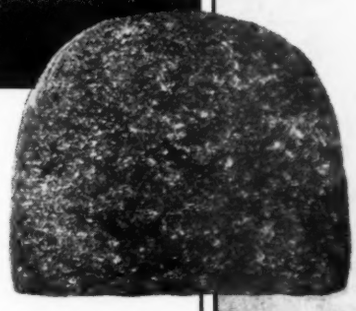
FOUNDRY



FORGE



BASIC



FOR MORE THAN HALF A CENTURY THE ***K.H.*** **BRAND** OF FOUNDRY AND FORGE PIG IRON HAS ESTABLISHED A REPUTATION FOR SUPERIOR QUALITY KNOWN AND ACCEPTED THROUGHOUT THE TRADE.

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Raw Material Markets

The demand for pig-iron has slowed down somewhat, and it is evident that the market has not yet adjusted itself to the new price levels. There are, of course, a large number of old orders to work off. All the furnaces have sufficient work on hand to keep them occupied for the next three months or so. The outlook is hence definitely promising, and the present lull in business should prove to be only temporary.

Pig-Iron

MIDDLESBROUGH.—Business has been quieter since the announcement of the 5s. per ton increase in Cleveland iron, but this was fully anticipated by the makers, who are already so heavily sold that they have little or no iron to offer for some months ahead. There are only four furnaces here producing foundry iron for the open market, and the shortage of supplies has necessitated the recent importation of Midlands iron into this area. The fixed home prices are now based upon No. 3 Cleveland G.M.B. foundry iron at 67s. 6d. per ton, delivered Middlesbrough, 69s. 6d. delivered North-East Coast, 67s. 3d. delivered Falkirk and 70s. 3d. delivered Glasgow. No. 1 foundry iron is 2s. 6d. per ton more than No. 3, and No. 4 foundry and No. 4 forge iron are 1s. per ton below No. 3.

Three blast furnaces were restarted on East Coast hematite last week, two at Normanby and one at Consett. Of the 26 furnaces now in blast on the North East Coast—compared with 20 at the end of 1933—there are nine making hematite iron. Hematite continues to be in heavy demand. The revised quotation is 67s. 6d. per ton f.o.t. makers' works for mixed numbers, with 6d. premium for No. 1 quality. The export quotation is 65s. per ton f.o.b.

LANCASHIRE.—Trading in pig-iron in this area has been largely featureless since the advent of the new prices, new buying having been restricted to small parcels for immediate use. The increases bring the new rates for Derbyshire, Staffordshire and North-East Coast brands of No. 3 foundry iron for delivery to users in the Manchester zone to 72s. per ton, while Northants is now quoted at 70s. 6d. and Derbyshire forge at 67s. Scottish foundry iron has advanced to about 85s. and East Coast hematite to around 81s., both delivered Manchester or equal. West Coast hematite continues to be quoted at about the same figure as East Coast, although an early readjustment in the case of the former is looked for.

MIDLANDS.—Market conditions have been quiet since the new rates came into force. There was a considerable amount of forward buying before the change, sales of Derbyshire iron being reported right up to next December. The new zone rates applying to the Midlands, and including delivery to Birmingham and Black Country stations, are 67s. 6d. per ton for Northants No. 3 and 71s. for Derbyshire, Lincolnshire and North Staffs No. 3, which figures are subject to rebate for large consumers, and to an extra of 7d. per ton for delivery to works. In respect to special irons, so far no alteration in prices has taken place, but it would not be surprising to find some of the irons in the medium-phosphorus category appreciating in value. At the present time these irons are quoted between 70s. and 80s. per ton, low-phosphorus from 80s. to 85s., and refined pig-iron for special work from £5 15s. to £6 15s. per ton delivered this district. Scottish No. 3 was advanced 5s. last week, making the figure delivered here 87s. 6d. per ton.

SCOTLAND.—Fairly heavy buying took place of both English and Scottish iron before the price increases took place, so that current business has naturally shown a falling off. A blast furnace has been relit on hematite. There are now eleven furnaces operating in Scotland, six on foundry, four on hematite and one on basic iron. Two more stacks are expected to be operating soon. The foundries in the Falkirk area remain very active, but the heavy foundries are still suffering from lack of work. The advance of 5s. per ton makes the minimum for No. 3 foundry 70s. f.o.t. furnaces. The prices for No. 3 Cleveland are now 67s. 3d. f.o.t. Falkirk and 70s. 3d. f.o.t. Glasgow.

Coke

Conditions in the foundry-coke market are unchanged, prices remaining firm. In the South Staffordshire area best Durham coke is quoted at 36s. 6d. to 40s., Welsh at 35s. to 47s. and Scottish at 39s. per ton, delivered Midland points.

Steel

Business in the steel markets remains quiet and some sections are still disturbed by the recent price advances and by the uncertainty regarding the proposed reorganisation scheme which will be considered at a meeting of the industry this week, states the official report of the London Iron and Steel Exchange. Export business still fails to develop, so that the lull in the demand from the home market is more noticeable. There is, however, an undertone of confidence, and the market generally considers that the present phase is only temporary. Dull conditions have ruled in the semi-finished steel department, as many of the consumers have covered their requirements for some time forward. The works, however, are operating at a satisfactory rate and there is some pressure by users to obtain delivery. Only a few transactions are reported in Continental material. The demand for finished steel has slackened, but the works are well provided with orders and anticipate a revival if the position with regard to reorganisation becomes clearer.

Scrap

The scrap-iron markets have generally shown a stronger tone following upon the recent advance in pig-iron prices. In the Cleveland area quotations are very much firmer at 59s. for machinery metal and 56s. for ordinary, light metal being at about 47s. 6d. per ton. In the Midlands, heavy machinery metal is at 55s. and good heavy at 50s. There is a good demand for scrap iron in Scotland, heavy machinery scrap, suitable for cupolas and in pieces not exceeding 1 cwt., being firm at about 58s. 6d. There is only a weak demand for heavy cast-iron scrap in South Wales, present quotations averaging 46s. to 47s. 6d.

Metals

Copper.—A slightly easier tone has been noticeable in standard copper quotations lately. Following upon the weaker tendency of the dollar, the market has experienced selling pressure from the United States. The European demand from consumers has been dull. Fortunately, however, there is a tendency for buyers to come forward when the price touches low levels, thus preventing a decline setting in.

The week's prices have been as follow :—

Cash.—Thursday, £32 7s. 6d. to £32 8s. 9d.; Friday, £32 11s. 3d. to £32 12s. 6d.; Monday, £32 5s. to £32 6s. 3d.; Tuesday, £32 13s. 9d. to £32 15s.; Wednesday, £33 to £33 1s. 3d.

Three Months.—Thursday, £32 11s. 3d. to £32 12s. 6d.; Friday, £32 15s. to £32 16s. 3d.; Monday, £32 8s. 9d. to £32 10s.; Tuesday, £32 17s. 6d. to £32 18s. 9d.; Wednesday, £33 3s. 9d. to £33 5s.

Tin.—There has recently been a slightly better demand for this metal. The tinplate industry in South Wales has been more active lately, and is reported to be now working at nearly 60 per cent. of capacity. The European demand is generally fairly good, whilst further shipments to America of English tin have recently been made from Liverpool. The stocks at the latter port are now below 7,000 tons, for the first time since May, 1929.

"The market continues to display no very definite tendency; the general position shows little or no material change and, pending a clearer outlook as to how consumption will develop in the next months and a more definite appreciation of the situation in America, buyers and sellers alike evince little disposition to open up fresh commitments," report Messrs. Rudolf Wolff. "Statistically, the position is expected to show some improvement again at the end of the month."

Daily quotations :—

Cash.—Thursday, £225 10s. to £225 12s. 6d.; Friday, £225 12s. 6d. to £225 17s. 6d.; Monday, £226 2s. 6d. to £226 5s.; Tuesday, £226 10s. to £226 12s. 6d.; Wednesday, £227 10s. to £227 12s. 6d.

Three Months.—Thursday, £225 5s. to £225 7s. 6d.; Friday, £225 12s. 6d. to £225 15s.; Monday, £225 17s. 6d. to £226; Tuesday, £226 5s. to £226 10s.; Wednesday, £227 2s. 6d. to £227 5s.

Spelter.—This market has still a rather easy tone. Although there are indications that consumption is gradually moving upward, at the same time supplies of metal are still easily available, although the cargoes of foreign spelter recently offering on the London market are reported to have been placed. European brassworks continue generally active, and there is a strong call for high-grade spelter.

Price fluctuations :—

Ordinary.—Thursday, £14 17s. 6d.; Friday, £14 16s. 3d.; Monday, £14 12s. 6d.; Tuesday, £14 15s.; Wednesday, £14 17s. 6d.

Lead.—Lead has been an uninteresting market and has relapsed to a slightly lower level, report Messrs. Brandeis, Goldschmidt. Consumers are not taking the tonnages which would be sufficient to cause an improvement in the price. Despite the absence of arrivals of bullion from Mount Isa in this country, owing to the temporary closing of the mine during the strike in Australia, there is no indication of any shortage of metal.

Daily market prices :—

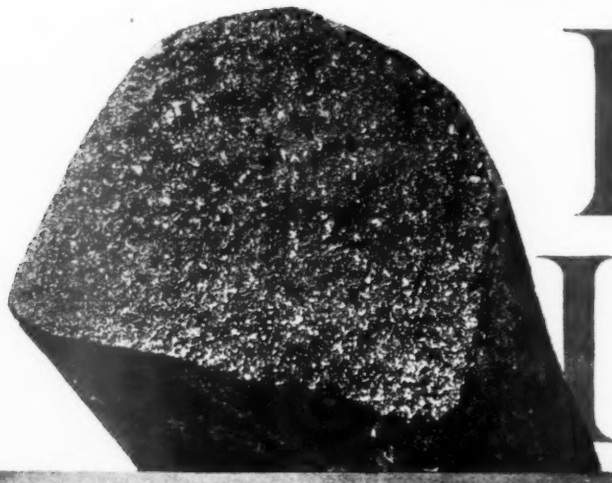
Soft Foreign (Prompt).—Thursday, £11 8s. 9d.; Friday, £11 10s.; Monday, £11 12s. 6d.; Tuesday, £11 15s.; Wednesday, £11 15s.

Corrosion of Steel by Gases

Technical Paper 560, "Corrosion of Steel by Gases Containing Traces of Hydrogen Sulphide: Effect of Pressure and Moisture Conditions," by J. M. DEVINE, C. J. WILHELM and L. SCHMIDT, issued by the U.S. Bureau of Mines, describes the results of an investigation of the corrosion of steel caused by natural gases containing traces of hydrogen sulphide (12 grains or less per 100 cub. ft. of gas). A tentative method for estimating the hydrogen sulphide content of such gases, and a testing apparatus for determining in the field the comparative corrosiveness of a gas at various pressure, are described. Use of this apparatus showed that traces of hydrogen sulphide in a gas may cause severe corrosion if oxygen and water are present. Two forms of corrosion were identified: (*a*) A less serious form, ordinary gaseous corrosion, in which no precipitated water was present on the surface of the metal, although the gas may be saturated with water vapour, and (*b*) a severe form, modified gaseous corrosion, in which precipitated water was present on the surface of the metal. Pressure accelerated the reaction in both forms of corrosion, but this effect was particularly noticeable with modified gaseous corrosion. The application of pressure to a gas also might increase the corrosion rate by causing precipitation of moisture on the surface of the metal, thus transforming ordinary gaseous corrosion to modified gaseous corrosion. The corrosion-threshold concentration of hydrogen sulphide, or the amount necessary for producing severe corrosion, was found lower for modified gaseous corrosion than for ordinary gaseous corrosion. Modified gaseous corrosion appeared to be the result of an electro-chemical reaction, while ordinary gaseous corrosion had the characteristics of a chemical attack. The corrosion rate with modified gaseous corrosion increased with a decrease in the thickness of the moisture film on the surface of the metal, but with continued reduction the reaction finally lost its electrochemical character and becomes ordinary gaseous corrosion. Modified gaseous corrosion could occur in the absence of hydrogen sulphide if oxygen were present; such corrosion, also, was accelerated by pressure. Steps that may be taken to reduce corrosion losses in pipeline systems are outlined in the Report.

MESSRS. SWAN, HUNTER & WIGHAM RICHARDSON, LIMITED, Wallsend, announce that the order they have just received from the Commonwealth & Dominion Line is for a motor-liner a little larger and faster than the "Port Chalmers," built for the same owners last year. The engines will be supplied by the Wallsend Slipway & Engineering Company, Limited, and will be of the Wallsend Sulzer type.

XUM



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RAW MATERIALS—PRICE LIST

(Wednesday, February 21, 1934)

COPPER

	£	s.	d.
Standard cash	33	0	0
Three months	33	3	9
Electrolytic	36	0	0
Tough	35	5	0
Best selected	35	15	0
Sheets	62	0	0
India	44	15	0
Wire bars	36	10	0
Ingot bars	36	10	0
H.C. wire rods	39	0	0
Off. av. cash, January	32	12	0 9/11
Do., 3 mths., January	32	14	8 11/11
Do., Sttlmnt., January	32	12	1 10/11
Do., Electro, January	35	18	6 9/11
Do., B.S., January	35	9	8 3/11
Do., wire bars, January	36	4	9 9/11
Solid drawn tubes			10d.
Brazed tubes			10d.
Wire			6½d.

BRASS

Solid drawn tubes	9d.
Brazed tubes	11d.
Rods, drawn	8⅜d.
Rods, extd. or rlld.	4½d.
Sheets to 10 w.g.	7½d.
Wire	7⅜d.
Rolled metal	7d.
Yellow metal rods	4½d.
Do. 4 × 4 Squares	5¾d.
Do. 4 × 3 Sheets	5¾d.

TIN

	£	s.	d.
Standard cash	227	10	0
Three months	227	2	6
English	228	0	0
Bars	229	10	0
Straits	231	10	0
Australian (nom.)	—		
Eastern	230	5	0
Banca	231	10	0
Off. av. cash, January	226	14	3 9/11
Do., 3 mths., January	226	15	8 2/11
Do., Sttlmt., January	226	14	1 1/11

SPELTER

	£	s.	d.
Ordinary	14	17	6
Remelted	14	15	0
Hard	12	0	0
Electro 99.9	17	0	0
English	15	7	6
India	13	15	0
Zinc dust	20	0	0
Zinc ashes	3	5	0
Off. aver., January	14	16	3 15/32
Aver. spot, January	14	13	9

LEAD

	£	s.	d.
Soft foreign ppt.	11	15	0
Empire	12	0	0
English	13	0	0
Off. average, January	11	8	2 23/32
Average spot, January	11	6	0 25/32

ALUMINIUM

Ingots	£100 to £105
Wire	1/1 to 1/9 lb.
Sheet and foil	1/2 to 2/9 lb.

ZINC SHEETS, &c.

	£	s.	d.
Zinc sheets, English	24	10	0
Do., V.M. ex whse.	23	5	0
Rods	29	0	0

ANTIMONY

	£	s.	d.	£	s.	d.
English	37	10	0 to	40	0	0
Chinese, ex-whse.				27	10	0
Crude				20	0	0

QUICKSILVER

	£	s.	d.	£	s.	d.
Quicksilver	10	5	0 to	10	12	6

FERRO-ALLOYS AND STEEL-MAKING METALS

Ferro-silicon—	
25%	£6 10 0
45/50%	£13 0 0
75%	£18 2 6
Ferro-vanadium—	
35 50%	12/8 lb. Va.
Ferro-molybdenum—	
70/75% carbon-free	5/6 per lb. of Mo.
Ferro-titanium—	
23/25% carbon-free	9d. lb.
Ferro-phosphorus, 20/25%	£14 10 0
Ferro-tungsten—	
80/85%	2/6 lb.
Tungsten metal powder—	
98/99%	2/9 lb.
Ferro-chrome—	
2/4% car.	£32 0 0
4/6% car.	£23 0 0
6/8% car.	£21 12 6
8/10% car.	£21 12 6
Ferro-chrome—	
Max. 2% car.	£37 10 0
Max. 1% car.	£38 15 0
Max. 0.70% car.	£42 0 0
70% carbon-free	10½d. lb.
Nickel—99.5/100%	£225 to £230
"F" nickel shot	£202 10 0
Ferro-cobalt, 98/99%	5/6 lb.
Metallic chromium—	
96/98%	2/5 lb.
Ferro-manganese (net)—	
76/80% loose	£10 15 0 to £11 5 0
76/80% packed	£11 15 0 to £12 5 0
76/80% export	(nom.) £9 15 0
Metallic manganese—	
94/96% carbon-free	1/2 lb.

Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL

Finished bars, 14% tungsten 2s. 0d.
Finished bars, 18% tungsten 2s. 9d.
Per lb. net, d/d buyers' works.

Extras—
Rounds and squares, 3 in. and over 4d. lb.
Rounds and squares, under ½ in. to ¼ in. 3d. lb.
Do., under ¼ in. to $\frac{1}{16}$ in. 1/- lb.
Flats, ½ in. × ¼ in. to under 1 in. × ⅜ in. 3d. lb.
Do., under ½ in. × ¼ in. 1/- lb.
Bevels of approved sizes and sections 6d. lb.
Bars cut to length, 10% extra.

SCRAP

South Wales—	£	s.	d.	£	s.	d.
Heavy steel	2	15	0 to	2	17	6
Bundled steel and shrngs.	2	7	6 to	2	15	0
Mixed iron and steel	2	10	0 to	2	12	6
Heavy cast iron	2	6	0 to	2	7	6
Good machinery	2	7	6 to	2	10	0
Cleveland—						
Heavy steel				2	12	6
Steel turnings				1	17	6
Cast-iron borings				1	8	9
Heavy forge				2	10	0
W.I. piling scrap				2	5	0
Cast-iron scrap	2	16	0 to	2	19	0
Midlands—						
Light cast-iron scrap				2	7	6
Heavy wrought iron				3	0	0
Steel turnings, f.o.r.				1	13	6
Scotland—						
Heavy steel	2	13	6 to	2	15	0
Ordinary cast iron				2	15	0
Engineers' turnings				2	2	0
Cast-iron borings				2	0	0
Wrought-iron piling	2	12	6 to	2	15	0
Heavy machinery				2	18	6

London—Merchants' buying prices, delivered yard.

	£	s.	d.
Copper (clean)	28	0	0
Brass	20	0	0
Lead (less usual draft)	10	10	0
Tea lead	8	0	0
Zinc	10	0	0
New aluminium cuttings	68	0	0
Braziery copper	26	0	0
Gunmetal	26	0	0
Hollow pewter	150	0	0
Shaped black pewter	105	0	0

PIG-IRON

(f.o.t. unless otherwise stated)

N.E. Coast (d/d Tees-side area)—	
Foundry No. 1	70/-
Foundry No. 3	67/6
,, at Falkirk	67/3
,, at Glasgow	70/3
Foundry No. 4	66/6
Forge No. 4	66/6
Hematite No. 1, f.o.t.	68/-
Hematite M/Nos., f.o.t.	67/6
N.W. Coast—	
Hem. M/Nos. d/d Glas.	72/6
,, d/d Birm.	84/6
Malleable iron d/d Birm.	115/-
Midlands (d/d Birmingham dist.)—	
Staffs No. 4 forge	67/-
,, No. 3 fdry.	71/-
Northants forge	63/6
,, fdry. No. 3	67/6
,, fdry. No. 1	70/6
Derbyshire forge	67/-
,, fdry. No. 3	71/-
,, fdry. No. 1	74/-
Scotland—	
Foundry No. 1	72/6
,, No. 3	70/-
Hem. M/Nos. d/d	71/-
Sheffield (d/d district)—	
Derby forge	64/6
,, fdry. No. 3	68/6
Lincs forge	64/6
,, fdry. No. 3	68/6
E.C. hematite	81/6
W.C. hematite	83/6
Lancashire (d/d eq. Man.)—	
Derby fdry. No. 3	72/-
Staffs fdry. No. 3	72/-
Northants fdry. No. 3	70/6
Cleveland fdry. No. 3	72/-
Dalzell, No. 3 (special)	102/6 to 105/-
Glengarnock, No. 3	85/-
Clyde, No. 3	85/-
Monkland, No. 3	85/-
Summerlee, No. 3	85/-
Eglinton, No. 3	85/-
Gartsherrie, No. 3	85/-
Shotts, No. 3	85/-

FINISHED IRON AND STEEL

Usual district deliveries for iron; delivered consumer's station for steel.

Iron—	£	s.	d.	£	s.	d.
Bars (cr.)	9	0	0 to	9	15	0
Nut and bolt iron	7	5	0 to	7	15	0
Hoops	10	10	0 to	12	0	0
Marked bars (Staffs) f.o.t.				12	0	0
Gas strip	10	10	0 to	12	0	0
Bolts and nuts, ¾ in. × 4 in.				13	15	0
Steel—						
Plates, ship, etc.	8	15	0 to	8	17	6
Boiler plts.	8	5	0 to	9	0	0
Chequer plts.				10	7	6
Angles				8	7	6
Tees				9	7	6
Joists				8	15	0
Rounds and squares, 3 in. to 5½ in.				9	7	6
Rounds under 3 in. to ⅝ in. (Untested)				8	12	0
Flats—8 in. wide and over				8	12	6
,, under 8 in. and over 5 in.				8	17	6
Rails, heavy	8	5	0 to	8	10	0
Fishplates	12	0	0 to	12	10	0
Hoops (Staffs)	10	10	0 & up.			
Black sheets, 24g. (4-t. lots)				10	5	0
Galv. cor. shts. (,,)				12	15	0
Galv. flat shts. (,,)				13	5	0
Galv. fencing wire, 8g. plain				14	0	0
Billets, soft				5	10	0
Billets, hard	6	17	6 to	7	2	6
Sheet bars	5	0	0 to	5	5	0
Tin bars				5	0	0

PHOSPHOR BRONZE

	Per lb. basis.
Strip	11d.
Sheet to 10 w.g.	12d.
Wire	11½d.
Rods	11d.
Tubes	15d.
Castings	13d.

Delivery 3 cwt. free.
10% phos. cop. £30 above B.S.
15% phos. cop. £35 above B.S.
Phosphor tin (5%) £30 above price of English ingots.
C. CLIFFORD & SON, LIMITED.

NICKEL SILVER, &c.

	Per lb.
Ingots for raising	7d. to 1/1
Rolled—	
To 9 in. wide	1/1 to 1/7
To 12 in. wide	1/1½ to 1/7½
To 15 in. wide	1/1½ to 1/7½
To 18 in. wide	1/2 to 1/8
To 21 in. wide	1/2½ to 1/8½
To 25 in. wide	1/3 to 1/9
Ingots for spoons and forks	7d. to 1/3½
Ingots rolled to spoon size	10d. to 1/6½
Wire round—	
to 10g.	1/4½ to 1/11½

with extras according to gauge.
Special 5ths quality turning rods in straight lengths, 1/3½ upwards.

AMERICAN IRON AND STEEL

At Pittsburgh unless otherwise stated.

	Dols.
No. 2 foundry, Phila.	19.26
No. 2 foundry, Valley	17.50
No. 2 foundry, Birm.	13.50
Basic, Valley	17.00
Bessemer	19.76
Malleable, Valley	17.50
Grey forge, Valley	17.50
Ferro-mang. 80%, seaboard	85.00
O.-h. rails, h'y, at mill	36.37½
Billets	26.00
Sheet bars	26.00
Wire rods	36.00
	Cents.
Iron bars, Phila.	1.89
Steel bars	1.75
Tank plates	1.79
Beams, etc.	1.70
Skelp, grooved steel	1.60
Steel hoops	1.85
Sheets, black, No. 24	2.25
Sheets, galv., No. 24	2.85
Wire nails	2.35
Plain wire	2.20
Barbed wire, galv.	2.85
Tinplates, 100-lb. box	$5.25

COKE (at ovens)

Welsh foundry	27/6
,, furnace	17/6 to 18/-
Durham foundry	21/- to 26/-
,, furnace	18/-
Midlands, foundry	—
,, furnace	—

TINPLATES

f.o.b. Bristol Channel ports.

I.C. cokes	20×14 per box		16/3 to 16/6
,,	28×20	,,	32/6 to 33/-
,,	20×10	,,	23/3 to 23/9
,,	18¾×14	,,	17/-
C.W.	20×14	,,	15/-
,,	28×20	,,	31/- to 31/3
,,	20×10	,,	21/6 to 21/9
,,	18¾×14	,,	15/- to 15/3

SWEDISH CHARCOAL IRON & STEEL

	£	s.	d.	£	s.	d.
Pig-iron	6	0	0 to	7	0	0
Bars-hammered, basis	16	0	0 to	16	10	0
Bars and nail-rods, rolled, basis	15	15	0 to	16	0	0
Blooms	10	0	0 to	12	0	0
Keg steel	30	0	0 to	31	0	0
Faggot steel	18	0	0 to	23	0	0
Bars and rods dead soft, st'l	10	0	0 to	12	0	0

All per English ton, f.o.b. Gothenburg.
[Subject to an exchange basis of Kr. 18.16 to £1.]

DAILY FLUCTUATIONS

Standard Copper (cash)

		£	s.	d.	
Feb.	15 ..	32	7	6	dec. 10/–
,,	16 ..	32	11	3	inc. 3/9
,,	19 ..	32	5	0	dec. 6/3
,,	20 ..	32	13	9	inc. 8/9
,,	21 ..	33	0	0	,, 6/3

Electrolytic Copper

		£	s.	d.	
Feb.	15 ..	35	10	0	dec. 7/6
,,	16 ..	35	10	0	No change
,,	19 ..	35	0	0	dec. 10/–
,,	20 ..	36	0	0	inc. 20/–
,,	21 ..	36	0	0	No change

Standard Tin (cash)

		£	s.	d.	
Feb.	15 ..	225	10	0	dec. 5/–
,,	16 ..	225	12	6	inc. 2/6
,,	19 ..	226	2	6	,, 10/–
,,	20 ..	226	10	0	,, 7/6
,,	21 ..	227	10	0	,, 20/–

Tin (English ingots)

		£	s.	d.	
Feb.	15 ..	226	0	0	dec. 10/–
,,	16 ..	226	5	0	inc. 5/–
,,	19 ..	226	15	0	,, 10/–
,,	20 ..	227	0	0	,, 5/–
,,	21 ..	228	0	0	,, 20/–

Spelter (ordinary)

		£	s.	d.	
Feb.	15 ..	14	17	6	inc. 1/3
,,	16 ..	14	16	3	dec. 1/3
,,	19 ..	14	12	6	,, 3/9
,,	20 ..	14	15	0	inc. 2/6
,,	21 ..	14	17	6	,, 2/6

Spelter (Electro, 99.9 per cent.)

		£	s.	d.	
Feb.	15 ..	17	2	6	No change
,,	16 ..	17	2	6	,, ,,
,,	19 ..	16	17	6	dec. 5/–
,,	20 ..	17	0	0	inc. 2/6
,,	21 ..	17	0	0	No change

Zinc Sheets (English)

		£	s.	d.	
Feb.	15 ..	24	10	0	No change
,,	16 ..	24	10	0	,, ,,
,,	19 ..	24	10	0	,, ,,
,,	20 ..	24	10	0	,, ,,
,,	21 ..	24	10	0	,, ,,

Lead (English)

		£	s.	d.	
Feb.	15 ..	12	15	0	dec. 5/–
,,	16 ..	12	15	0	No change
,,	19 ..	12	15	0	,, ,,
,,	20 ..	13	0	0	inc. 5/–
,,	21 ..	13	0	0	No change

Imports and Exports of Pig-Iron, Iron and Steel Castings, etc., in January, 1934, compared with January, 1933 and 1932

	January, 1932.	January, 1933.	January, 1934.	January, 1932.	January, 1933.	January, 1934.
Imports.	Tons.	Tons.	Tons.	£	£	£
Pig-iron, forge	10	—	—	70	—	—
,, foundry	4,253	3,413	3,411	15,144	11,625	9,725
,, acid	1,005	1	—	3,016	6	—
,, basic	6,728	5,031	6,601	17,605	13,840	17,601
Total (including other kinds)	11,996	8,445	12,161	35,835	25,471	40,101
Castings and forgings	297	81	158	5,401	1,917	4,224
Cast pipes and fittings	188	171	108	3,151	3,433	4,549
Stoves, grates, etc.	251	55	64	34,068	5,872	5,422
Baths	369	287	707	9,895	6,232	17,107
Hollow-ware, all kinds	93	74	271	4,835	4,419	13,773
Exports.						
Pig-iron, forge	161	142	31	764	630	107
,, foundry	5,875	3,512	4,855	21,596	11,840	17,362
,, acid	5,626	2,757	3,364	18,498	8,694	10,336
,, basic	—	190	545	—	725	1,747
Total	11,662	6,601	8,795	40,858	21,889	29,552
Castings and forgings	262	143	310	9,661	5,358	12,370
Cast pipes and fittings, over 6 in. diameter	1,848	2,406	3,183	15,401	16,910	26,404
,, ,, ,, up to 6 in. ,,	4,092	3,163	4,373	53,543	38,366	56,674
Stoves, grates, etc.	666	460	747	31,901	22,155	38,599
Sanitary cisterns	311	217	298	9,736	6,581	8,366
Bedsteads and tubes therefor	434	323	626	18,182	12,740	19,131
Cast hollow-ware	218	340	317	10,386	13,282	13,043

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PIG

IRON

All grades FOUNDRY, HEMATITE, BASIC, SPECIALS, &c.

NON-FERROUS METALS

COPPER, TIN, LEAD, SPELTER, ANTIMONY, CHROME ORE.

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ZETLAND ROAD, MIDDLESBROUGH.

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(A remittance should accompany instructions.)

SITUATIONS VACANT AND WANTED

ADVERTISER, well established among iron-founders with travelling Midland Counties and Lancashire, is desirous of selling pig-iron for a blast-furnace company.—Address, Box 654, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

FULLY-QUALIFIED Foundry Plant Superintendent desires change. Latest methods of mass production, light castings.—Box 664, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

STEEL Foundry Foreman requires situation; 25 years' experience in marine, locomotive, electric, motor, and general engineering castings; plain carbon and alloy steels; electric, open-hearth and converter processes; excellent references.—Box 668, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

A SPLENDID opportunity occurs, in well-known, old-established malleable-iron business, for Working Foundry Foreman, able to take full control. Must have had actual experience in patternmaking, cupola work, stump and machine moulding (small articles), also annealing by gas oven.—Write, stating age, wage, and full particulars of experience, to Box 656, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

EMPLOYMENT REGISTER.

Conducted by the Institute of British Foundrymen by courtesy of the proprietors of THE FOUNDRY TRADE JOURNAL.

Correspondence should be addressed to the General Secretary, Institute of British Foundrymen, St. John Street Chambers, Deansgate, Manchester, from whom full particulars can be obtained of this service.

Any employer wishing to communicate with a candidate should write to the General Secretary, quoting identification number.

FOREMAN Patternmaker desires re-engagement. Has had experience in similar capacity with well-known firms making light repetition castings for the motor and electrical trades. Specialist on machine and platework. (238)

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CAPITAL offered for established business definitely showing net profit. Active Partnership or Directorship required.—Write, WALSH, 65, New Bond Street, London, W.1.

BUSINESSES FOR SALE AND WANTED

WANTED Purchase, established Pig-iron Merchant's Business, preferably one with promising export connections.—Full details in strict confidence, Box 670, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

FOR Sale.—Private Limited Company incorporated in Portugal, owning ironfoundry and general engineering workshops at Oporto suitable for adaptation to varied engineering purposes.—Box 652, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

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By Direction of TRIPLEX FOUNDRY, LIMITED, GREAT BRIDGE, STAFFS, who are shortly removing to their New Foundry at Tipton.

FOR SALE BY PRIVATE TREATY,
WITH POSSESSION ON COMPLETION,
The Substantially-built and Extensive
FREEHOLD MANUFACTURING PREMISES,
Situate at Bridge Road and Toll End Road,
GREAT BRIDGE, TIPTON, STAFFS,
COMPRISING A TOTAL AREA OF 20,900 SQUARE YARDS
with RUNWAYS and FIRST-CLASS MELTING PLANT by arrangement if required).

There is a frontage to Canal Basin of about 1,000 ft. The distance from the L.M. & S. and G.W.R. Goods Stations at Great Bridge is ¼-mile, and services include South Staffs and Canal Water Supplies, Gas and Electric Light and Power.

First-class South Staffordshire labour is available in the district.

Further particulars and Permits to Inspect may be obtained from J. V. BOSWELL & COMPANY, F.A.I., Auctioneers and Valuers, 4, Waterloo Road, Wolverhampton (Telephone 21216/7), or MESSRS. CHESSHIRE, GIBSON & COMPANY, F.A.I., Auctioneers and Valuers, 21, Waterloo Street, Birmingham (Telephone Midland 6651/2).

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WELL-BUILT & COMMODIOUS OFFICES
Will Sell whole or in lots to suit customers or Let on favourable terms. Unique opportunity for Manufacturers.

Apply—
THOS. W. WARD, LTD.,
ALBION WORKS, SHEFFIELD.

MACHINERY

BRINELL Testing Machine required, second-hand; must be in good condition. Hydraulic type preferred, 3,000-kg. load.—S. RUSSELL & SONS, LIMITED, Bath Lane, Leicester.

SANDBLAST PLANTS

Room, Rotary Barrel and Cabinet Types complete; 12 in stock.

SAND PLANT

Sand Mills, 6-ft., 5-ft. and 4-ft. 6-in. dia. Pans.
Rotoil "Senior" Oil Core Sand Mixer.
Pneulec Sand Drying Plant, output 1 ton per hour.
Brearley Type Disintegrators.

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Hand and Pneumatic Types.
Also
Six Rowlands Double-ended Grinders for 24-in. dia. x 2-in. wheels.
Electrical and Belt-driven Blowers and Exhaust Fans, Ladles, etc., etc.

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All sizes for high and low pressures.

S. C. BILSBY, A.M.I.C.E., A.M.I.E.E.
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'Phone: Broadwell 1359.

MACHINERY—*Continued*

SURPLUS Foundry Plant, in excellent condition, for disposal.—Address inquiries to Box 662, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

THOS. W. WARD, LTD.

250-kw. Steam GENERATING SET (Belliss & Morcom), 460 v., 380 revs.
Rotary Bar CUTTING-OFF MACHINES, cap. 6" to 9" dia. bars.
Pneumatic SAND MOULDING MACHINE, cap. admits boxes 16" x 16" x 6".
4 LANCS BOILERS, 30' x 8', 200 lbs. w.p.

Write for "Albion" Catalogue.

'Grams: "Forward." 'Phone: 23001 (10 lines).
ALBION WORKS, SHEFFIELD

MISCELLANEOUS

PATTERNS.—Inquiries solicited; quotations by return; shop equipped with modern machinery; quick delivery.—CLEGHORN & COMPANY, Midland Pattern Works, Spring Gardens, Worcester. 'Phone 264

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In Stock, Slough: send for List.
ALL Sizes from 10 cwts. to 10 tons.
ALL Ladles warranted: state size required.

ANY LADLE SENT ON APPROVAL.

ALEX. HAMMOND, 14, Australia Road, Slough.

PATTERNS.—Inferior Patterns make trouble in the foundry. Why not buy the best—they cost very little more.—Send to FURMSTON & LAWLOR, Letchworth, Herts.

'Phone: 287 SLOUGH

SANDBLAST PLANTS

12' × 9' Tilghman sandblast room, built of cast iron plates, complete with 400 cu. ft. Tilghman air compressor and all accessories **£290 Nett.**

6' × 6' × 8' Tilghman Sandblast room, similar to above, but with B.H.2 Tilghman horizontal compressor: price complete **£130.** Several small Tilghman plants.

6' "Jackman" rotary sandblast table. CHEAP seen working.

SAND PLANT

Herbert "Whizzer" type disintegrator, No. 1	**£30**
Rotary Sand Dryer by Titan	**£55**
Gyratory sand riddle with motor	**£7**

Large "Baillott" sand preparing plant CHEAP.

BUY FROM ME AND SAVE MONEY!

ALEX. HAMMOND, *Foundry Machinery Merchant,*
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